New Impact Formulas Needed in Designing Bridges of Various Types, *by J. A. L. Waddell*

Engineering News-Record

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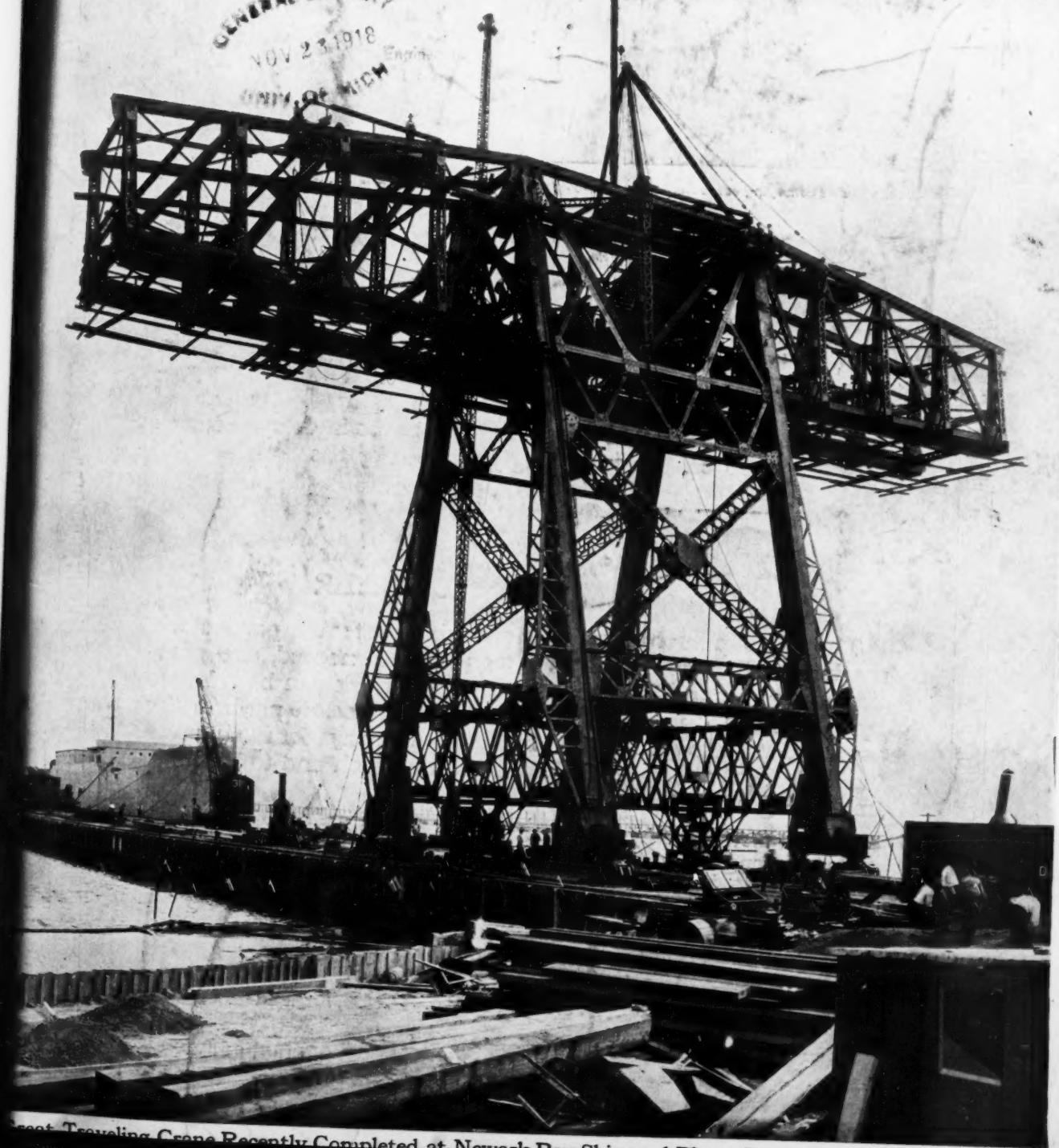

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E. J. MEHREN, *Editor*

CHARLES WHITING BAKER, *Consulting Editor*

New Impact Formulas Needed in Designing Bridges of Various Types 924

By J. A. L. Waddell.

Scarcity of experimental knowledge of impact shown by review of tests and studies—Group of formulas proposed—Lower impact allowances for solid-floor bridges and concrete arches.

Engineering News-Record, Nov. 21, 1918. 10 cols. Ill.

Central Plant for Sharpening Drill Steels Saves Money in Quarrying 929

Sharpening Shop with two men replaces five smithies—Equipment comprises steel conveyor, oil-fired furnace and concrete quenching vats.

Engineering News-Record, Nov. 21, 1918. 3¼ cols. Ill.

Sewage Mixes Progressively in Its Passage Through Tanks 930

By H. W. Clark.

Lawrence Experiments with activated-sludge and settling tanks show that common assumptions are not founded on fact.

Engineering News-Record, Nov. 21, 1918. 2¾ cols. Ill.

Circular Earth Embankment Lined With Concrete Forms Oil Reservoir 932

Type Originated in California—Introduced in Texas oil fields on account of lack of steel—Concrete roof carried on wood frame also because of scarcity of structural steel for supports.

Engineering News-Record, Nov. 21, 1918. 6 cols. Ill.

Principles on Which the French Highways Are Built 935

By Capt. Frank W. Harris.

Roman System of direct lines between strategic points followed—Great attention is given to drainage.

Engineering News-Record, Nov. 21, 1918. 1¼ cols. Ill.

Some Heavy Fitting-Out Cranes—II. Cantilever and Jib Travelers at Newark Bay and Bristol 937

Double Cantilever bridge traveling along pier commands line of ships either side—Provision for extension—Friction draft-gear buffers—Tower jib crane fitted with special safety devices.

Engineering News-Record, Nov. 21, 1918. 9¼ cols. Ill.

Urges Electrification of the California Railroads 941

D. F. Folsom of oil division of Fuel Administration points to oil and capital economy—Purchase of power.

Engineering News-Record, Nov. 21, 1918. 2¾ cols.

What and Where to Buy 146
Searchlight Section

Oiled Macadam Roads Resurfaced With Concrete 943

By E. A. Burt.

Los Angeles County, California, builds roads in two sections to keep traffic moving—Center joint divides traffic.

Engineering News-Record, Nov. 21, 1918. 4 cols. Ill.

Some Experiences With Large-Capacity Reservoir Outlets 945

By James M. Gaylord.

Specially Designed gates control discharge of immense volumes of water under pressures above 200 feet—Difficulties and how overcome.

Engineering News-Record, Nov. 21, 1918. 10¼ cols. Ill.

One Set of Wood Forms Used Three Times Completes Concrete Foundry 950

By J. M. Villadsen.

Form Units assembled on ground with reinforcement in place erected by derrick—Telescoping chute placed concrete.

Engineering News-Record, Nov. 21, 1918. 2¾ cols. Ill.

Special Paints for Concrete Ships 951

Engineering News-Record, Nov. 21, 1918. ¼ col.

Hints for the Contractor 956

Other Articles of Interest to Contractors:

Central Plant for Sharpening Drill Steels Saves Money in Quarrying

Some Heavy Fitting-Out Cranes—II. Cantilever and Jib Travelers at Newark Bay and Bristol

One Set of Wood Forms Used Three Times Completes Concrete Foundry

Editorials 921

Engineering Literature 952

Society Service 954

Letters to the Editor 954

Construction News 247

Index to Advertisers 152
53-82

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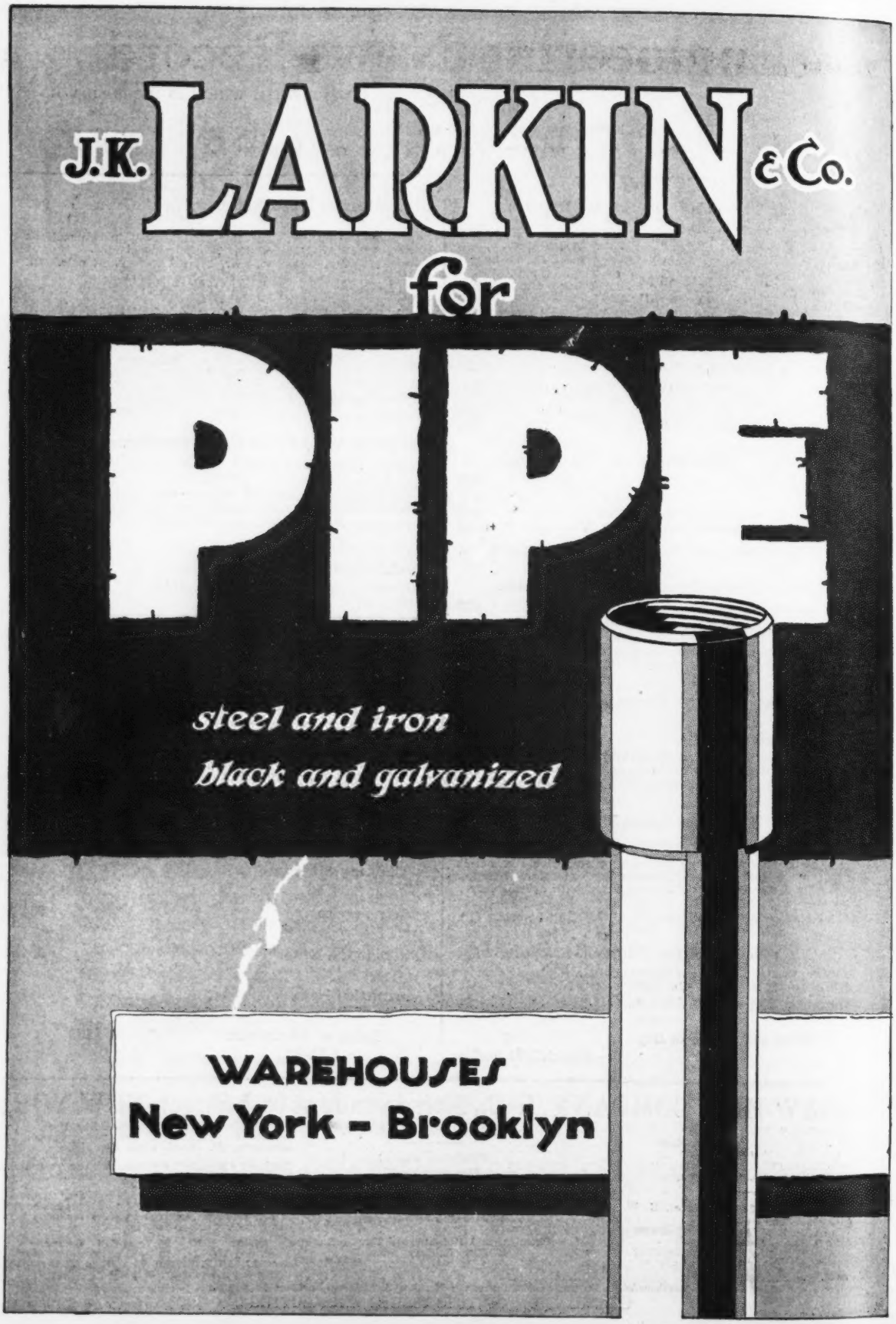
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E. J. MEHREN, *Editor* — CHARLES WHITING BAKER, *Consulting Editor*

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Let Public Works Take Up the Slack

EACH day that labor is unemployed there is an economic loss to the community. Every man not employed is either a public charge or an idle producing unit, and since it is certain that return to a peace basis will take some time, public works should absorb labor as fast as possible, even under conditions which might seem uneconomical on account of high wage scales and high prices of materials. Even if the public pays a greater price for public improvements, it prevents the economic loss due to idle man-power. If, to prevent unemployment, the army is demobilized slowly, the public pays for the maintenance of the soldiers. It would be better to demobilize as promptly as the military situation permits, increasing the amount public work to such an extent as to prevent unemployment. Such a course would mean permanent and substantial returns for the money spent, whereas the maintenance of men in camp after the military necessity ceases is a dead loss.

A Slogan for Reconstruction

WITHOUT guiding principles of high character no movement or agency can come to great success. The war, for example, took on a new character after President Wilson had crystallized its purpose—"to make the world safe for democracy." In this period, similarly, the results will be great or small, lasting or ephemeral, according to the spirit by which reconstruction is animated. Some may want to restore the pre-war status in its fullness, regardless of cost, others may contend for all the structure and gains of war times without recognizing the disappearance of the conditions which brought them about. Between these contenders will be all manner of compromise positions, based, in many cases, upon the personal advantage of the scheme to the proponent. It will be difficult, of course, to eliminate selfishness, but after what the world has endured in these four terrible years it should be possible to get men in the mass to accept in so great an enterprise high ideals and guiding principles. So only can we bring out of the welter of war a better social order and one that will be lasting. We waged the war for "justice and humanity." So let us carry on our reconstruction. War-made institutions should be judged by those standards, and fall if they fail to conform to them. The time for idealism and sacrifice did not end on Nov. 11. It will not end until the last adjustment between war times and peace has been made.

Restrictions Removed From Road Building

IT IS good news to the highway engineers and builders of this country that all restrictions (save those relating to the obtaining of steel and the floating of bond issues) have been removed from highway building. Simultaneously with their removal the function of the United States Highways Council ceases. For the last there will be no regrets. The council, charged with a selective task, interpreted its work as being almost wholly restrictive, and its record accordingly is not such that its late demise will cause any sorrow. Highway work can now go forward wherever money is available from taxes, while, in addition, it is reasonably certain that the Capital Issues Committee will look with favor upon bond issues for road work. In fact, we expect the committee to welcome such issues, for a large amount of work must be undertaken shortly if we are to pass from a war to a peace basis without widespread unemployment. It is not too much to say, therefore, that the restrictions on highway building are off and that the road needs of the country can again be fully met. There is big work to be done, and in the doing of it the highway builders of the country will be sure of full support from the public.

Reconstruction Before the War-Service Committees

IN THE first week in December there will be a general meeting in Atlantic City of the war service committees created at the suggestion of the Government in some 367 industries or crafts. "What of reconstruction?"—that is the big question which the committees have been asked to face. In a sense, it will be the introduction of the industries of the country to their new rôle, that of demobilizing industry, of foreseeing the difficulties that are ahead and of arranging for an orderly and peaceful transfer of the country's factories and enterprises from a war to a peace basis. The meetings will be of tremendous importance. On the decisions reached will depend the attitude of the nation's industries during reconstruction. That the decisions will be wise, that they will be vigorous, that they will be so appealing as to win universal support, will be the prayer of every American. The penalty for vacillation, for selfishness, for a weak attack is serious for industry and for the country; under those conditions the thinking business men of the nation would have little influence on the progress of reconstruction, and the whole great problem would be cast into the hands of the politicians. Already the latter

are quarreling over its handling. If they are allowed, unchecked by the thinking elements of the community, to settle the grave questions at issue on the basis of bargaining and political advantage, the country is destined to suffer from the mischief that will ensue.

Engineer Heads Citizenship Efforts

AS A reconstruction measure, the Dallas Chamber of Commerce has appointed an engineer to develop a department to increase community spirit and character of citizenship. Successful business development, just like successful community life, is more dependent upon character of citizenship than on increase in population or in number of factories. Charles Saville, the new director, is a sanitary engineer, has been connected with the Dallas Board of Health for several years and has traveled much abroad. He is well fitted by experience for this important task. Mr. Saville recognizes that two of the most important industrial problems are labor shortage and the lack of sympathy and coöperation between capital and labor. He proposes to meet the former difficulty through increased labor efficiency, by making the worker's home and his community surroundings more desirable. A bureau of industrial relationships will study local labor problems and be prepared to ease the relations between employers and employees. It will anticipate and relieve certain kinds of working conditions before they become so intense as to cause serious and difficult situations. That Dallas has chosen an engineer for this work is gratifying. Accustomed to studying causes and effects and trained in the search for facts, he is better qualified than any other specialist for such a task. The profession will be glad of Mr. Saville's opportunity and will be interested in the results.

Engineer Personals

NEWS of the movements of engineers—their appointments, promotions, changes and resignations—is of such interest in professional and commercial circles that the notes published in the "Personal" columns of *Engineering News-Record* weekly are very widely read. Very soon they will receive added importance, because we shall try to record therein the return to civil life of the thousands of engineers and contractors who have been in the service of their country. As our readers well know, we tried to record their entry into military or public service. That was important, because it showed the extent to which engineers and contractors were backing the Government in its great enterprise. Yet the new "personals"—those of demobilization—will be all the more important because they will enable friends to get in touch again with each other and will tell to all interested in engineering work the positions which the returned soldiers and civilians in Government service have taken up. For the supply of news of this sort reliance must be placed largely on those directly concerned or on their friends and business associates. We strongly urge upon all of our readers the prompt sending to us of news of the reëntry into civil life of men from the civil engineering ranks, both engineers and contractors. We shall avail ourselves of the ordinary military and public sources of information, but these will not tell the positions to which the men are going. Of course, we want news of all changes pertinent to the civil engineering field, but at this time in particular we appeal to readers for news regarding those who are leaving the service of their country, whether they have been in uniform or not.

Primitive Construction Methods Necessary in an Age of Tools

CONSTRUCTION methods of the pioneer, despite a quarter of a million miles of railway and our multitude of machines, have an important place in the work of the engineer even today. The mechanical helps of the lumberman are many and most efficient, but the constructor must still go ahead and with axe and saw and the other simple tools of the pioneer prepare the way for their use. So also, as was described in last week's issue, the constructor of drainage works in the tamarack and cypress swamps of Minnesota and Arkansas must build extensively by pioneer methods in preparation for the work of his giant land and floating dredges. Talent of a special kind is demanded of these pioneer builders, and experience and practice count more heavily in reaching success than they do where the paths have been marked by textbook and pocket manual. It is a real test of the engineer's talent as a builder, to go into the woods with no more materials and tools than a team can haul in a woods wagon and cut and hew and assemble and erect the timbers for an 80-ft. span truss bridge. Let us not forget to salute this man among construction engineers.

Abandoning the Electric-Railway Ship

"ABANDONING an electric-railway ship" may be a horribly mixed way of stating the situation, but abandonment is just what some electric-railway operators are now advocating. Early this month there was introduced at a meeting of the American Electric Railway Association a resolution urging upon the member companies that they facilitate in every reasonable way the acquisition by the public of the present electric-railway properties and assist in the promotion of the necessary enabling legislation. The introduction of such a resolution in an association of this sort is cause for surprise, especially as it came from the president of the Milwaukee Electric Railway & Light Co. and had the support of the president of the United Railways Co. of St. Louis. The resolution has been submitted to the member companies for letter ballot.

It is not conceivable that the association will indorse it. While the electric-railway properties of the country are in bad shape financially, it is unlikely that their owners will "throw up the sponge." In fact, we feel that local conditions in Milwaukee and St. Louis biased the judgment of those who fathered the resolution. It has the outward appearance of corporate weariness and a desire to be rid of difficulties.

We may sympathize with the individuals in their trouble, but instead of just quitting we expect from them a solution which will be for the best interests of the public. Why, otherwise, have they been managing *public-service* enterprises? A paper read just before the introduction of the resolution very surprisingly stated that all problems of service, rates of wages, rates of

fare, etc., could be better solved under public than under private ownership. If that is true, then electric-railway operators—and also the operators of other public utilities privately owned—have been dishonest with themselves and with the public for these many years. They have contended that private operation was better for the public than public operation. In this view *Engineering News-Record* still persists. We believe that there are certain advantages in private operation that cannot be obtained, in the present state of civic development, under public operation. But private operation, if it is to be governed by the type of brains or lack of brains which has characterized much of the electric-railway operation of this country, can never expect to succeed. The electric railways are in their present position largely because they deserve it.

What we should expect from an association such as that of the electric railways is a broad consideration of all of the factors affecting electric-railway operation, all questions being constantly referred back to the primary purpose—the best service to the public. Such an inquiry, we believe, would result in an indorsement by the association of the partnership type of operation, such as obtains in a number of cities of the Middle West. Here there is close community control, with an assurance that the company cannot profiteer. On the other hand, the benefits of private operation are retained.

Will the electric railways abandon the ship, or will they fight for a solution best for the public and fair to themselves?

Caution Necessary in Revising the Shipbuilding Program

CHANGES in ship demand came upon the world suddenly with the end of active warfare. A month ago the call was for ships, ships of any kind so long as they were ships—wood, steel, concrete; small or large; economical or wasteful in coal and crew expense—no matter, provided they would float and carry cargo across the seas. Today the demand is for ships that can meet commercial needs and compete on even terms with the rest of the world's fleet.

It is inevitable that shipbuilding should be adjusted to the new demands. The nation's enterprise of building a merchant marine sufficient for all its transportation needs will fail if its ships are not efficient as carriers on the ocean trade routes. We must build the best and most serviceable vessels which the naval architect's skill can produce.

But above all, we must build ships. The momentum of our new shipbuilding industry may not be checked. The need of the day is to stimulate rather than diminish the zeal of shipbuilders. They are now burdened with the double responsibility of maintaining production though radically altered working conditions are in prospect, and preparing for changes in their product and methods to enable them to enter competitive commercial work as soon as the Government may direct.

Encouraging words were spoken last week by the Shipping Board authorities and by the Secretary of the Navy. Their message was that full activity in shipbuilding is to be maintained. And the people of the country are heartily with them in this resolution. The country demands undeviating pursuit of the merchant-marine ideal. It demands also that the hundreds of millions of investment in the shipyards shall remain at work, for it knows that present safety depends upon wise conservation and upbuilding.

Abrupt revision of the shipbuilding program will accomplish the very opposite result, however. New forces of great magnitude have been brought into action in speeding the construction of ships. If these forces are paralyzed—except on the clearest justification of compelling necessity—the stability of the industry will be gravely menaced.

Wooden, concrete and fabricated-steel vessels were created. Each drew into its service vast resources of men and materials. Are these to remain at work or be eliminated? Are they to be released to individual initiative? The yards of the Lakes were set to work building seagoing ships, small, it is true, but vital in our emergency. Shall they continue in the work?

These questions demand early answer. Yet it is of the utmost importance that they be answered in the right way. The danger of disruptive and disorganizing changes in the shipbuilding program is close at hand.

There is another new condition that has been created by the return of peace to the seas. Coöperation of the entire country in the high-pressure work of shipbuilding will henceforth be contingent on the country's participation in shaping the policies; and this participation must be based on knowledge of the underlying facts. Information on ship service and shipyard operations had to be withheld from public knowledge while the war was in progress, and policies had to be shaped by decree—a condition which the country willingly accepted during the war. An opposite procedure now becomes necessary—clearest and fullest publicity.

Are concrete and fabricated-steel ships justifying themselves in service and cost? Have wooden ships made a success? Is the service of the Great Lakes vessels satisfactory? No light has been thrown on questions of this kind in the months past. Yet further action in respect to the shipbuilding program is bound to depend on them. Let it be recognized that such action will secure public support only in the degree that the underlying facts are made known. To engineers in particular these facts are important; and if, for example, radical changes are to be made in the program for building concrete ships or fabricated-steel ships, they are not likely to accept the decision unless it is preceded by adequate justification by facts.

In the revolution through which shipbuilding has gone, there are involved potential changes in ocean shipping conditions also. No one man, and no small group of men, possesses the foresight needed for safely making far-reaching decisions on future shipping. There are many signs to indicate that, just as life-long shipbuilders have in recent times acquired new views of their art and its possibilities, so the men who carry on the world's shipping are remodeling their traditions and are arriving at a new knowledge of ships. In the light of this contingency, it is even more emphatically necessary for our Shipping Board, when it undertakes revision of the shipbuilding program, to proceed with utmost caution and in partnership with the country.

New Impact Formulas Needed in Designing Bridges of Various Types

Scarcity of Experimental Knowledge of Impact Shown By Review of Tests and Studies—Group of Formulas Proposed—Lower Impact Allowances for Solid-Floor Bridges and Concrete Arches

By J. A. L. Waddell
Consulting Engineer, Kansas City, Mo.

RECOGNITION of the fact that impact effects are less in solid-floor bridges than in bridges with light wooden floors, and less in solid-filled masonry arches than in steel bridges, has been quite general among bridge engineers for years past, but no formulas expressing this fact quantitatively have become established. Such formulas are needed for safe and economical designing. The writer therefore proposes a group of formulas, covering all the principal types of bridges, based in part on a discussion of impact tests and in part on long experience in bridge design.

It is necessary first to establish clearly what impact in bridges really is. Many engineers believe that impact allowances either cover or should cover the prejudicial effects of shock, vibration, alleged fatigue of metal, eccentricities, secondary stresses, and minor imperfections in manufacture—in fact, that they usurp the function of what the late C. Shaler Smith used to term "the factor of ignorance." Such is not the case. As the bridge designer applies it, *impact is the measure of the difference in the effects of any load applied dynamically and applied statically.*

In amount, impact varies greatly with the governing features of the structure, the character of the loading, the velocity of the moving load, the conditions of track and rolling stock, etc. The bridge engineer naturally is concerned only with its maximum values; hence, in determining formulas and diagrams for impact, the worst probable conditions are always assumed.

It is difficult to divorce the idea of impact from that of secondary stress; and in one sense it is impracticable to do so, because impact applies to secondary as it does to primary stresses. If the impact allowance increases the computed static primary stress in any bridge member 25%, it will increase also by 25% any secondary stress that may exist simultaneously therewith in that member. Secondary stresses are due mainly to eccentricities of connections and to distortions of rigidly-connected members under load; and it is evident that these, as well as the direct or primary stresses, are augmented by shock or vibration.

First Impact Tests Made Seventy Years Ago

The existence of impact on bridges was recognized as far back as the middle of the past century, for in 1849 some crude experiments were made by an English engineer named Willis by running a carriage variously loaded, and at different velocities, over a pair of iron bars 9 ft. long. The deductions drawn from the experiments were that the deflections increased with the velocity, at least up to a certain point, and that they reached to two or three times the static ones; but the bars were made so light that their deflections were proportionately too great to be compared with those of a bridge.

In 1875 the late J. T. Fanning obtained diagrams of the motion of a bridge under live load at or near mid-span, by means of a platform supported by the ground and entirely disconnected from the structure.

In 1881 H. Sabine and the late Prof. S. W. Robinson made some records of deflections at both center and quarter points of a 60-ft. Howe-truss span, which was one of a pair of continuous spans. They found an impact varying from 6 to 12% with velocities not exceeding 30 miles per hour.

In 1881 Dr. W. Fränkel of Germany invented his extensometer and made a few tests with it for secondary stresses, but did not then apply it to the determination of impact. In 1884, however, he used it for this purpose, in connection with his deflectometer, on different members of railroad bridges; and in 1887 similar experiments were made by him on an iron rocker-pier viaduct at Weida.

Between 1881 and 1887 Prof. S. W. Robinson, during tours of inspection of certain Ohio railroads, made a number of deflection tests on bridges; and in the latter year he read before the American Society of Civil Engineers an important paper entitled "Vibration of Bridges." In it he showed impact records running as high as 50%, with an average for a dozen cases of 26½ per cent.

Impact tests were started in France in 1891 by M. Cüenot. He experimented upon a 35-m. span, and found with a train-velocity of 22 miles per hour an impact of 22%. These tests were followed there in 1892 by those of M. Deslandres, who experimented upon a 30-m. highway span. He discovered that the vibration due to the passage of a single horse and cart at a trot caused a deflection as great as one-half of that from the maximum load when statically applied. Three horses and carts, weighing altogether less than 10,000 lb., when passing at a trot gave approximately the same deflection as that of the said statically applied maximum loading.

Rabut's Formula Developed From Tests

The most important impact experimenting done in France was the work of the writer's friend, Col. Charles Rabut. He started his investigations in 1892 and completed them in five years. He obtained impacts ranging from 10% to 50%, and established for short spans the formula,

$$I = \frac{1}{1 + \left(\frac{L}{4}\right)^2}$$

where L is the span in meters.

J. Melan of Austria in 1893 made a mathematical analysis of impact for various span lengths, finding values varying from 77% for 5-m. spans to 15% for 120-m. spans.

In 1899 Prof. F. E. Turneaure of Wisconsin began

his famous research on the effect of impact, which he has continued up to the present time. Of late years his work has been done in connection with the American Railway Engineering Association, in which he acts as chairman of a special committee. His first tests were made on plate-girder spans varying in length from 25 to 80 ft., and on truss bridges with spans from 100 to 200 ft., mainly under regular railroad traffic. The largest value for impact which he then found was 50%. About the same time E. Herbert Stone conducted an extensive series of experiments upon impact on railroad bridges in India, finding a maximum value of 50% for short spans.

Schneider Formula Used For Many Years

As early as 1887 the late C. C. Schneider, afterwards president of the American Society of Civil Engineers, had proposed the formula,

$$I = \frac{300}{L + 300}$$

in which I is the coefficient for impact and L is the length in feet of that portion of the span which is covered by the moving load when the member under consideration receives its greatest live-load stress.

This formula was used for many years thereafter, indeed until five or six years ago.

Theodore Cooper may be said to have covered the effect of impact in some of his earlier specifications for bridge designing, when he provided that the working intensities applied to dead-load stresses should be twice as great as those applied to live-load stresses. For instance, D being the dead-load stress and L the live-load stress, and the intensity for tension being 10,000 lb. for live load, the intensity for dead load would be 20,000 lb., and the sectional area required would be given by the equation,

$$A = \frac{L}{10{,}000} + \frac{D}{20{,}000} = \frac{2L + D}{20{,}000}$$

This means that the impact allowance for the live-load stress in any part of any kind of bridge of any span length should invariably be 100%; or, in other words, that the live load is always twice as effective (or destructive) as the dead load, no matter whether the piece under consideration be the beam hanger of a suspended cross-girder or the chord of a 500-ft. span. A number of American railway engineers, when writing bridge specifications for their systems, copied this feature and continued to employ it for many years, notwithstanding its *prima facie* lack of soundness.

Confusion Caused By the Fatigue Fallacy

For more than a decade many American bridge specifications were cursed with a provision against an imaginary fatigue of metal, based upon the results of the investigations of some German scientists, who, in their testing, stressed metal *beyond the elastic limit* many times in quick succession—often until rupture was accomplished. Sometimes the experiments were in either tension or compression only, but in some cases they were alternately in each. Certain American engineers, who apparently desired to be progressive, incorporated this fatigue-of-metal idea into bridge building by employing for intensities of working stresses factors involving maximum stress and minimum stress, thus greatly augmenting the work of bridge computers. A few American bridge specialists, however, among them the writer, from time to time protested against both the uselessness and the incorrectness of the alleged refinement; and gradually the objectionable feature disappeared from our standard bridge specifications. The logical reason for abandoning the burdensome practice was that fatigue of metal does not occur until after the elastic limit is passed, and in bridge designing it is customary to limit the intensities of working stresses to one-half of this for combined live, impact, and dead loads, and to seven-tenths thereof for the most improbable combination of maximum stresses due to all the kinds of loadings that are ever considered in bridge designing as acting simultaneously.

A very satisfactory proof of the incorrectness of the fatigue-of-metal theory in bridges was given in *Engineering News-Record* of Apr. 4, 1918, by George H. Pegram, past president of the American Society of Civil Engineers, who made a number of tests on metal specimens cut from one of a lot of stringers that were removed from a New York City elevated railroad. Mr. Pegram could find no evidence whatsoever of any fatigue, notwithstanding the fact that the stringer thus tested had withstood the passage of fully one hundred million wheel loads.

Recent Experiments and Conclusions

In 1891 the writer, in a paper presented to the American Society of Civil Engineers, entitled "Some Disputed Points in Railway Bridge Designing," made an earnest appeal to the engineering profession for a systematic study of the question of impact on bridges; and in 1896, when preparing the manuscript of his "De Pontibus," he outlined a series of tests which he contemplated making. The project fell through, but early in 1902, when examining bridges on the International & Great Northern Ry. in Texas, the writer was able to make numerous experiments on deflections, using for the purpose a somewhat crude but quite efficient deflectometer constructed in his own office. He found impacts varying from 50% on an 88-ft. deck open-webbed riveted span to 20% on truss spans not exceeding 160-ft. in length. He learned then a very curious fact, viz., that for identical superstructures the amount of impact is dependent upon the character of the supporting substructure; because in the case of several spans of 159 ft. resting on masonry piers the percentage was 20, while it was 40 for two similar spans on small cylinder piers.

No other step of any importance was taken in America to study systematically the question of impact on railroad bridges until 1907, when the American Railway Engineering Association appointed a committee to make a thorough investigation of it. That committee in 1911 issued a report indicating that it had experimented upon 21 plate-girder spans up to 100 ft. in length, and upon 24 truss spans from 100 to 250 ft. in length, using generally enough loaded cars to cover the span tested, and employing speeds from 10 to 60 miles or more per hour. From that report are taken the following statements and conclusions:

For speeds under 10 or even 15 miles per hour the recorded impact was practically zero.

The chief factors in causing impact are unbalanced locomotive drivers, rough and uneven track, flat or irregular wheels, eccentric wheels, rapidity of application of load, and deflection of beams and stringers. (The term "impact" was considered by the committee to include any effect of the moving load which results in primary stresses exceeding the static stresses).

With the track and the rolling stock in good shape, the chief cause of impact is the unbalanced condition of the drivers of the ordinary locomotive. This condition does not exist in balanced four-cylinder locomotives or in well designed electric locomotives.

Recommendations of A.R.E.A. Committee

The committee corroborated the fact, discovered long ago by Prof. S. W. Robinson, that the maximum impact on a bridge is dependent upon how nearly its normal rate of vibration coincides with the times of the series of impulses from the unbalanced-driver loads. The critical speeds observed varied from 65 miles per hour for 60-ft. spans to 25 miles per hour for 300-ft. spans and to 20 miles per hour for a 440-ft. span. This corroborated the results of the writer's experiments, previously mentioned, in which he found for spans of 150 or 160 ft. critical speeds of 35 or 40 miles per hour. The committee also noted, as the writer had anticipated many years previously, that the impact on the separate main members of a span is greater than that upon the structure as a whole, or, in other words, that extensometer measurements give somewhat larger results than deflectometer measurements.

The committee suggested two formulas for impact based on these experiments: viz.,

$$I = \frac{1}{1 + \frac{L^2}{20{,}000}} \text{ and } I = \frac{60}{L}$$

where I and L have the same significance as in the Schneider formula previously quoted.

New Formula Proposed Two Years Ago

The summary of the committee's report given on p. 41 of Part 3 of the American Railway Engineering Association's *Proceedings* for 1911 (and reproduced on pp. 125 and 126 of the writer's "Bridge Engineering") makes very interesting reading.

Its subsequent report, published on p. 115 of the 1916 *Proceedings*, recommends a new formula,

$$I = \frac{1}{1 + \frac{L^2}{30{,}000}}$$

This is an improvement on the two others previously recommended; nevertheless, the curve which it represents passes beneath some of the plotted points for comparatively long spans.

In Volume CC of the *Proceedings* of the Institution of Civil Engineers, p. 178, there is a valuable paper by Charles William Anderson, entitled "On Impact Coefficients for Railway Girders," in which, among other matters, he deals with some experiments conducted in India by the government bridge engineer, H. S. Sales, deducing the following impact formula:

$$I = \frac{50}{50 + L}$$

The author of the paper states that "the formula has no direct scientific basis." It does not cover all the maximum results of the experiments, and he expresses some doubt about its being "sufficiently liberal for new girders." When the corresponding curve is plotted on a diagram upon which are marked the results of the A. R. E. A. experiments, the insufficiency of the proposed formula becomes very apparent. (See the accompanying diagram, Fig. 1.)

Experiments made in the summer of 1917 by Prof. F. E. Turneaure on spans varying from 60 to 240 ft. under trains hauled by electric locomotives form the latest contribution to the test record. His general de-

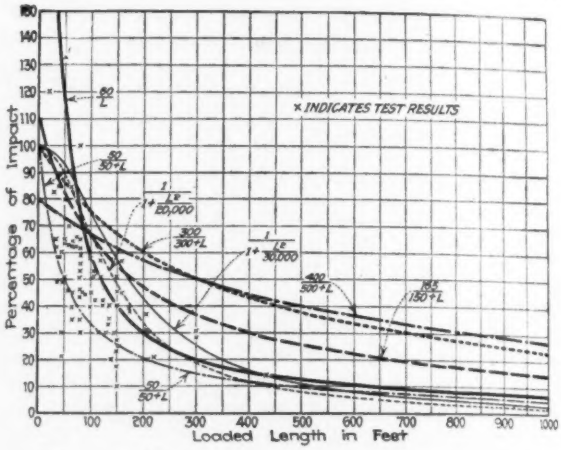


FIG. 1. SOME IMPACT FORMULAS INADEQUATE TO COVER MAXIMUM TEST RESULTS

duction is that "it appears to be fairly well established that the impact effect from electric locomotives is very much less than that from steam locomotives of the usual type"—in fact, not to exceed one-third thereof.

This information, which is about all of any value that the profession possesses concerning impact from electric locomotives, is of great importance. In view, however, of the paucity of such experiments, the writer suggested in a letter to Professor Turneaure that, for the present at least, it might be well, as a matter of precaution, to assume that impact on bridges from electric locomotives is about one-half of that from steam locomotives; and to this Professor Turneaure agreed. He says—quoting from his letter in reply—"Of course, in adopting a formula for actual use on the basis of the limited amount of experimental work we have done, it would be wise to be on the safe side; and an allowance of one-half would be very reasonable from this standpoint. As I now think the matter over, I do not see that there would be any great difference in relative effect on different members of the bridge, as our experience throughout has shown an overpowering effect of the unbalanced parts of the steam locomotives."

Various Formulas Compared

The preceding condensed history contains references to practically all the investigations of any importance yet made. Some others there were, it is true, but as the results thereof were not conclusive they have not been mentioned.

While there have been numerous impact formulas advocated during the past three decades, only two of them

have been employed at all generally—that of Schneider and the writer's modification of it; viz.,

$$I = \frac{400}{L + 500}$$

Concerning the latter formula, the writer two decades ago in the first edition of "De Pontibus" stated as follows:

"This formula was established to suit the average practice of half a dozen of the leading bridge engineers of the United States, as indicated in their standard specifications, and not because the author considers that it will give truly correct allowances for impact. In spite of all that has been said to the contrary in the past or that may be said in the future, the impact method of proportioning bridges is the only rational and scientifically practical method of designing, even if the amounts of impact assumed be not absolutely correct; for the said method carries the effect of impact into every detail and group of rivets, instead of merely affecting the sections of the main members, as do the other methods in common use."

In the twenty years since, the writer has found in his practice no reason for doubting the correctness of this opinion. It is true that the elaborate series of experiments conducted by the American Railway Engineering Association has shown that the old formulas give results which are too low for very short spans and are unnecessarily high for very long ones; but the variations on the side of danger have not been at all serious, nor have those on the side of safety been excessively extravagant.

In "Bridge Enginering," on pp. 125 and 127, are recorded various recognized impact curves and numerous points indicating the results of the A. R. E. A. experiments. From these has been prepared the diagram marked Fig. 1, which shows the old Schneider and Waddell curves, the three curves corresponding to the proposed formulas of the A. R. E. A. committee, the new British curve derived from the Indian railways experiments, and a curve lately suggested by the writer in "Bridge Engineering;" and also records, by crosses, the before-mentioned results of the A. R. E. A. experiments.

From this diagram it will be seen that the Schneider formula gave more correct results than the writer's modification thereof, both being on the safe side for spans of 100 ft. and over but on the danger side for the shorter spans. The new English formula is seen to be entirely inadequate, being generally on the side of danger. The three proposed formulas of the American Railway Engineering Association pass beneath a number of the plotted points, and the two complex ones fail to give any values greater than unity, just as did the old Schneider and Waddell formulas.

Single-Track and Multiple-Track Impact Formulas

Basing on this graphical comparison, the writer contends that his single-track impact formula,

$$I = \frac{165}{L + 150}$$

provides better results than any of the others, being somewhat on the side of safety for spans longer than those which have thus far been tested for impact.

Unfortunately, the experimenting done thus far has been mainly upon single-track structures. Consequently, the formulas for double-track and multiple-track structures have had to be established by *a priori* reasoning. The writer's formula for steam-railway bridges is

$$I = \frac{165}{nL + 150}$$

where n is the number of tracks carried by the structure.

If we compare the values given by this formula for double-track and for single-track bridges, we find that the ratios vary from 0.71 for short spans to 0.55 for long ones, with an average of about 0.59. If we assume, which is more than probable, that a load on one track only will produce quite as large an impact effect on the nearer truss as that which would exist with both tracks loaded (because the vibrations from the two trains tend to check each other), the ratios of impact value for double-track and single-track structures will be the same as those of the live loads per truss for one track only loaded and both tracks loaded. These ratios vary from 0.73 for short spans to 0.7 for long ones. As it is likely that a live load on a double-track bridge will give percentages of impact a trifle lower than the same live load would on a single-track bridge (because of the greater shock-absorbing capacity of the former), it is probable that the writer's formula when applied to double-track bridges is sufficiently accurate.

Concerning its correctness for a still greater number of tracks, it is almost entirely useless to make any surmise, because there are no data whatever to go by. The fact that for very long spans the formula when applied to multiple-track bridges gives values of less than 5% is a fair indication of its probable reliability within reasonable limits.

Impact on Electric-Railway and Highway Bridges

In establishing his impact formula for electric-railway bridges,

$$I = \frac{120}{nL + 175}$$

the writer depended solely upon his judgment. The results of this formula for both single-track and double-track bridges are about 70% of those found by the formula for steam-railway structures. Judging by the correspondence with Professor Turneaure, previously referred to, it would have been more nearly correct to write it with 84 in the numerator. In that form it gives results so close to those of the writer's formula for impact in highway bridges, viz.,

$$I = \frac{100}{nL + 200}$$

that the latter may properly be assumed to cover both highway and electric-railway structures. When tested against the impact formulas for single-track and double-track steam-railway bridges, it indicates ratios varying from 0.5 for short spans up to 0.6 for long ones; hence, it should certainly be safe and suitable for both electric-railway and highway structures. In the latter the value of n is the total width in feet of the entire deck divided by 20, while in the former, of course, it is simply the number of tracks on the structure.

When one considers that rapidly passing motor trucks on the rough pavements of highway bridges are

just as likely to produce high values of impact as are easy-riding trains on the comparatively smooth track-rails of electric-railway bridges, it is evident that there is no incongruity in employing the same impact formula for these two classes of structure.

In Fig. 2 are plotted the impact curves for single-

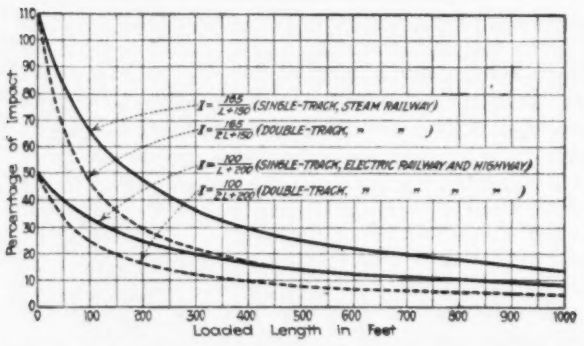

Percentage of Impact
Loaded Length in Feet
I= 165/L+150 (SINGLE-TRACK, STEAM RAILWAY)
I= 165/2L+150 (DOUBLE-TRACK, " ")
I= 100/L+200 (SINGLE-TRACK, ELECTRIC RAILWAY AND HIGHWAY)
I= 100/2L+200 (DOUBLE-TRACK, " " " ")

FIG. 2. EFFECT OF DECK WIDTH AND BRIDGE SERVICE ALLOWED FOR BY RECOMMENDED FORMULAS

track and double-track steam-railway loads and for single-track and double-track electric-railway loads. The last two curves, as before noted, apply also to highway loadings.

Impact Allowances for Special Cases

In figuring loads on foundations the impact is generally taken as zero. This is all right for heavy bridges, especially if the piers are massive; but for light structures resting on slender piers a certain amount of impact should be included, ranging from about one-half that of the trusses or girders for trestles down to about one-quarter of the same for long spans. This is a matter in which judgment based upon wide experience should govern. It must not be forgotten that the impact for a pier must be computed for a length of structure equal to the sum of the lengths of the two spans which it helps to support.

All the formulas for impact on railway bridges hereinbefore discussed are predicated upon the employment of open floors of the ordinary type of railway track; and those for highway bridges upon using plank flooring supported on timber joists. If, instead, a reinforced-concrete base to support the track or the pavement be adopted, its massiveness will certainly aid materially in checking vibration and, therefore, in reducing impact; but to what extent no one can say until an elaborate series of experiments is made. In the writer's opinion, the solid floor will probably reduce the impact about 25 per cent.

Modifications for Concrete Open-Spandrel and Filled Arches

Again, the impact on reinforced-concrete arch rings is very much less than that on trusses of steel railway bridges with open decks or on those of steel highway bridges with wooden floors; because, in addition to the rigidity obtained from the reinforced-concrete base, there is that due to the massiveness of the cross-girders and columns or the cross-walls, as the case may be. On these accounts, the writer believes that the impact on arch rings for open-spandrel arch bridges may safely be taken as one-half of that adopted for the trusses of the corresponding steel structures with flooring of light type.

Finally, for the arch rings of earth-filled arch bridges, shock and vibration are so absorbed by both the massiveness of the concrete construction and the inertia of the superimposed earth filling that it will be proper to assume the value of the impact to be only one-fourth of that for the before-mentioned trusses of the corresponding steel structure with light flooring.

Recommended Formulas Summarized for Ready Reference

Recapitulating, we have the following impact formulas to cover all kinds of bridges:

Steam Railway Structures:

For steel bridges,

$$I = \frac{165}{nL + 150}$$

in case of open floor;

$$I = \frac{124}{nL + 150}$$

in case of ballasted floor on concrete base.

For reinforced-concrete structures, excepting spandrel-filled arch bridges,

$$I = \frac{83}{nL + 150}$$

For spandrel-filled arch bridges,

$$I = \frac{41}{nL + 150}$$

Highway and Electric-Railway Structures.

For steel bridges,

$$I = \frac{100}{nL + 200}$$

in case of light floor;

$$I = \frac{75}{nL + 200}$$

in case of heavy, solid floor.

For reinforced-concrete structures, excepting spandrel-filled arch bridges,

$$I = \frac{50}{nL + 200}$$

For spandrel-filled arch bridges,

$$I = \frac{25}{nL + 200}$$

These eight formulas may be condensed into two, thus:

Steam Railway Structures,

$$I = \frac{165A}{nL + 150}$$

Highway and Electric-Railway Structures,

$$I = \frac{100A}{nL + 200}$$

where A has the following values: For steel bridges with open or light floors, 1.00; for steel bridges with heavy, solid floors, 0.75; for reinforced-concrete structures, excepting spandrel-filled arch bridges, 0.50; and for spandrel-filled arch bridges, 0.25.

Central Plant for Sharpening Drill Steels Saves Money in Quarrying

Sharpening Shop with Two Men Replaces Five Smithies—Steel Conveyor, Oil-Fired Furnace and Concrete Quenching Vats

SUBSTITUTION of a central drill-sharpening plant for scattered blacksmith shops has reduced the cost and increased the efficiency of drilling operations at the 10 quarries of the Boutwell, Milne & Varnum Co., Graniteville, Vt. An hour a day derrick time hoisting drills has been saved at each quarry, and the labor of five blacksmiths and their five helpers has been eliminated. Drills are kept running a larger part of the time, and, due to machine sharpening, the cutting speed is greater.

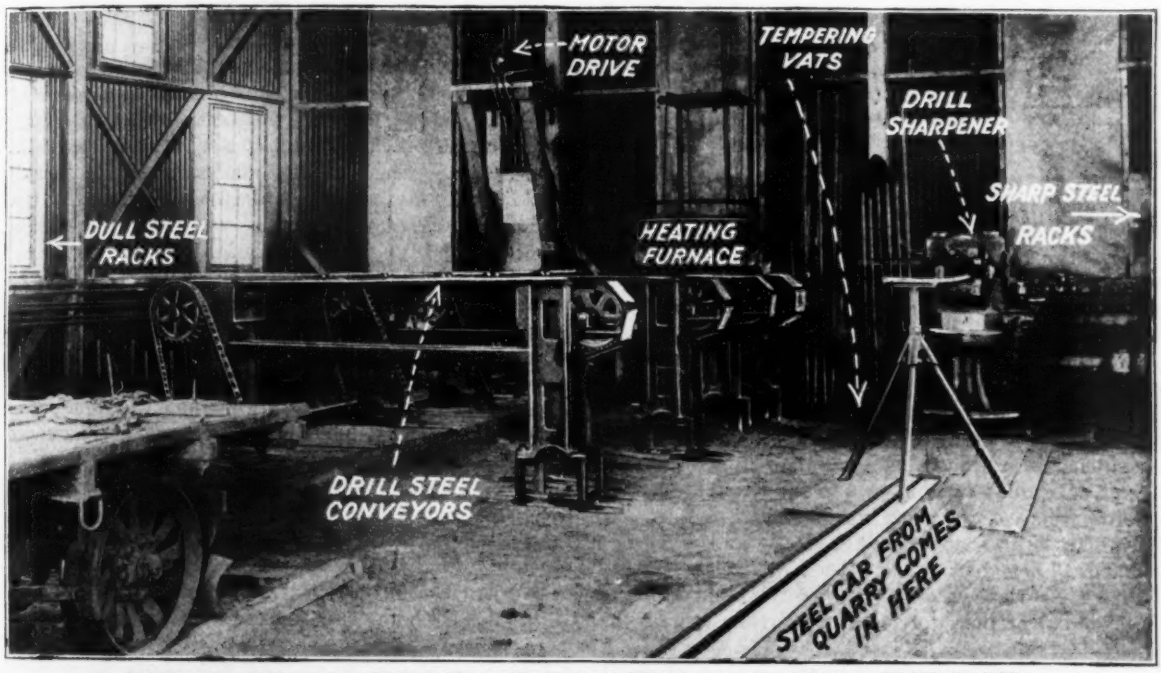
Housed in a metal-covered wood-frame building 39 x 27 ft., the sharpening outfit comprises a heating furnace and drill conveyors, a drill sharpener, a tempering vat, roof cranes and drill racks. About 300 drills, reamers and broachers can be sharpened in an 8-hour day. The furnace and the conveyors which serve the furnace are of the type made by the Pirie Sharpening Machine Co., Barre, Vt. Any length of drill steel, from 1 ft. to 25 ft., is handled by the conveyors, which have chain speeds of 4½, 6 and 9 in. per minute. This range of speeds gives ample variation of heating time for all sizes of bits, both for sharpening and tempering. The furnace is kerosene-fired by a Gilbert-Barker No. 5 high-pressure burner consuming about 12 gal. per eight-hour day. A 300-gal. underground tank supplies the oil. Improvement has been made in the furnace as ordinarily installed. A counterweighted brick drop curtain was added. By means of this curtain, which can be raised or lowered according to the size of bit being heated, the heat is concentrated on the bits to a greater extent than ordinarily.

Five different types of drills, most of them tripod drills, are employed in the quarries; the total is 47 drills. Rock conditions call for four types of bits, cross-bits, bull-bits, reamers and broachers, and two shapes of steel, quarter-octagon and hollow-hexagon, in four sizes of 1, 1½, 1¾ and 1⅞ in. All drills using the 1¼-in. hollow-hexagon steel are equipped with an improved type of chuck using steel without shanking. This type of chuck was designed and made by the company for private use in its quarries.

Bits are formed and sharpened in an Ingersoll-Leyner No. 5 sharpener, with certain changes made by the quarry company from its own designs. The mode of sharpening the cross-bits has been improved by using dies with round openings instead of octagon, by which it becomes possible to make the wings of the bit on the corners of the steel instead of on the flat. All cross-bits are made this way; there is less steel to upset, and the bits mud more freely because of the greater clearance.

When the plant was put into operation, trouble was experienced from the drills rifling. By changing the gaging blocks to decrease the taper of the wings of the bit from 14 deg. to 2 deg., the trouble was eliminated and the cutting speed increased. Bit gages have been standardized, so that only two separate sets of gaging blocks are used, one set for the large steel and the other for the small, each set with 12 gages differing 2/32 in. These blocks are used for the quarter-octagon steel only; the 1¼-in. hollow-hexagon steel is gaged by standard gaging blocks.

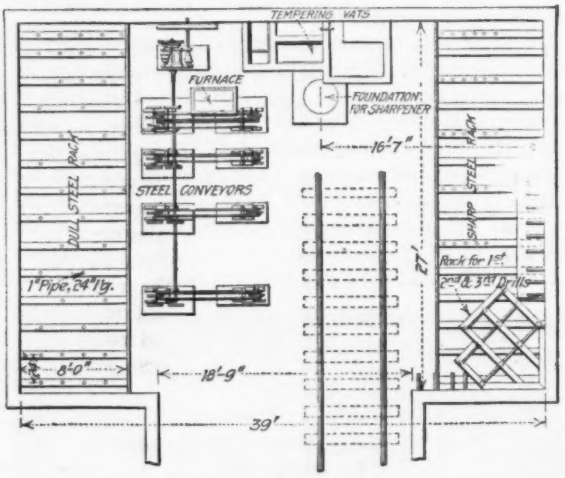
The tempering vat is made of reinforced concrete with a waterproof asphalt lining. It is partitioned off into four compartments. Gratings are used in these compartments to obtain the proper depth of immersion, ¾ in. The first two compartments are used for tempering steels up to 10 ft. in length, while a third compartment is for longer steels. The solution, a brine of 100 lb.



DRILL STEEL MOVES ACROSS PLANT FROM DULL-STEEL RACKS TO SHARP-STEEL RACKS

of salt to 50 gal. of water, is pumped from the fourth compartment to the first and second, overflows to the third (a trough to the bottom of the compartment prevents spattering) and thence back to the fourth, as indicated by the drawing of the vats.

When a car loaded with dull steels enters the shop the crane unloads it and places the steels in the dull-steel rack, then reloads from the sharp-steel rack with

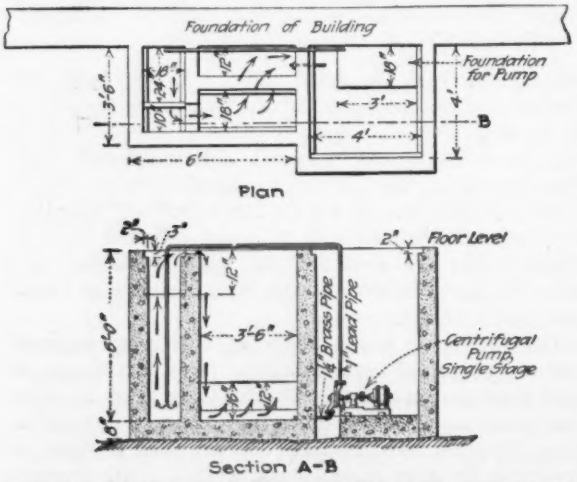


FLOOR PLAN OF DRILL-SHARPENING PLANT SERVING TEN QUARRIES

duplicates of the steels brought in. The racks are so arranged that there is place for every type of bit and length of steel. A surplus of sharp steel is always kept on hand, so that cars can be reloaded without delay.

Two men operate the plant, one overseeing the heating of the steel and the other handling the sharpener. After the steel is sharpened it is laid aside until nearly cold. Then it is returned to the conveyors, reheated to a dark cherry red, quenched, and allowed to remain in the vat until cold; after it goes to the sharp steel rack.

Before this central plant was installed each quarry had a blacksmith shop where the drills were sharpened by hand. Each drill runner also had his own kit of drills. Time was wasted by the derricks in hoisting the drills out of the quarries, and the time lost by the



BRINE FLOW IN TEMPERING VATS IS KEPT CONTINUOUS BY PUMPING

drill helpers waiting in the shops for the drills to be sharpened was excessive. These losses have been eliminated by the central plant.

The plant was designed and constructed under the supervision of Guy R. Varnum, superintendent (now captain, ordnance department, U. S. A.). The changes made in the equipment of the plant for its successful operation under the conditions encountered were planned and carried out by E. D. Palmer, acting superintendent, W. H. Paine, master mechanic, and H. B. Wallis, mechanical engineer.

Sewage Mixes Progressively in Its Passage Through Tanks

Lawrence Experiments With Activated-Sludge and Settling Tanks Show That Common Assumptions Are Not Founded on Fact

BY H. W. CLARK

Director and Chemist, Division of Water and Sewage Laboratories and Lawrence Experiment Station, Massachusetts State Department of Health

ALTHOUGH it is recognized that many factors enter into the manner and time of the passage of water or sewage through sedimentation or activated-sludge tanks, yet it is generally assumed that the time of passage is equal to the number of hours that it would take to fill the tank at a given rate of flow. How far off this assumption may be was shown by studies made during 1917 at the Lawrence Experiment Station of the Massachusetts State Department of Health. In these studies an investigation was made of the actual rate and manner of flow of liquids through activated-sludge tanks Nos. 485 and 486, and through a plain sedimentation tank of different size and shape. Starting with full tanks, the liquid entering the tanks was always so treated with either common salt or ammonium chloride that the time of its appearance at the outlets of the tanks could be easily determined. It was also possible to determine at any time the proportion which the effluent of the tanks contained of the treated sewage passing into the tank and of the sewage held in the tank when each experiment was started.

In the work here described the activated-sludge tanks were so operated that theoretically the sewage in the different tests was 6, 9½ and 10½ hours in passing through. Diagrams illustrating the results of this study are here reproduced. At the time of two of the experiments illustrated, Tank No. 485 consisted of three main sections, each 8 ft. in depth above conical bottoms, while at the time of a third experiment two of these sections each contained a baffle across its center reaching 3 ft. below the surface of the sewage in the tanks. When the experiments were made air was being applied to the sewage at the rate of 150,000 cu.ft. per hour per 1,000,000 gal. of sewage passing through the tanks, and of course the entire depth of liquid in all sections of the tank was in a state of quite violent agitation.

Turning to Fig. 1, it will be noticed that in one experiment with Tank No. 485 while the theoretical time of the passage of sewage through this tank when it was applied at the rate followed was 10½ hours, yet certain volumes of the applied sewage appeared at the outlet of the tank in practically one hour; 50% appeared in

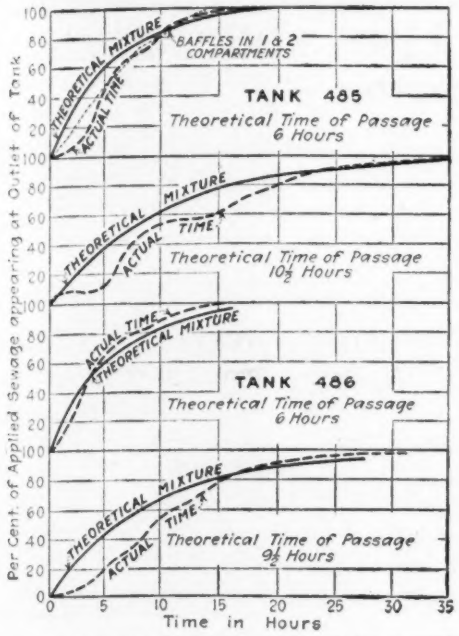


FIG. 1. THEORETICAL AND REAL SEWAGE MOVEMENTS IN ACTIVATED-SLUDGE TANKS DO NOT AGREE

7½ hours; while the remaining 50% lagged to such an extent that only after the expiration of 35 hours had all this sewage, which theoretically should have passed through in 10½ hours, finally passed from the tank. That is, the effluent was always a mixture of applied and held sewage, some of the applied sewage having been treated in the tank less than an hour while some was treated for periods which varied from 1 to 35 hours.

On the diagram (Fig. 1) a second curve is given with each experiment illustrated, this curve being intended to show the *theoretical mixture* of applied and held sewage in such a tank when this sewage is passed into the tank at the rate followed during the experiments just described, and the liquid in the tank, considering it all as one compartment, is in a state of thorough agitation.

It will be noticed that this second curve and the curve showing the actual manner of passage of the sewage are very similar; that is, in a tank of this description, even with three compartments and at times with baffles in two of these, the sewage does not pass through as a compact body of liquid but as a *progressive mixture*. Theoretically, when such a tank is being operated on a 10-hour storage basis and a mathematically correct progressive mixture is taking place, 10% of the sewage would appear at the outlet of the tank in the first hour, 9% additional the second hour and 8.1% additional the third hour, etc.; or, expressing it in another way, a total of 10, 19 and 27.1%, etc., of this entering sewage should appear at the outlet of the tank at the end of the first, second and third hours, respectively. These figures are perhaps not absolutely correct, but only higher mathematics could express them exactly.

Fig. 2 shows also experiments and observations of this nature when the sewage was passing through a second baffled activated-sludge tank (No. 486) theoretically in 6 hours. The results of these experiments and many others carried on by us prove clearly the fact here illustrated; namely, the progressive mixture of applied and held sewage in tanks which are operated in this way.

Further experiments have been made, one or two of which can be mentioned here, using a small tank 31 ft. long, 31 in. wide and 30 in. deep (Tank K). In the experiments mentioned here, this tank was so baffled that the entering sewage passed below the first baffle near the inlet of the tank, and at the outlet of the tank rose above a second baffle before reaching the outlet. Sewage was passed into this tank in a series of experiments so that theoretically it should, in the different experiments, have been 4, 6 and 8 hours in passing through if passing as a solid body. The results obtained, however (Fig. 2) were practically the same as with the activated-sludge tank just described. Curves on these diagrams show that when operated on the 4-hour time-of-passage basis, 50% of the entering sewage reached the outlet in 4 hours, while the remaining sewage lagged to such an extent that it was 15 hours before all had reached the outlet. The 6-hour and 8-hour experiments show similar results.

In this wooden tank, in which the sewage was not agitated by air, the temperature of the water in different parts and depths of the tank varied to a slight extent, and these differences in temperature of course caused this water or sewage to pass in more or less stratified layers. In all activated-sludge tanks and sedimentation tanks greater efficiency is probably obtained when all the sewage passes through as a fairly compact

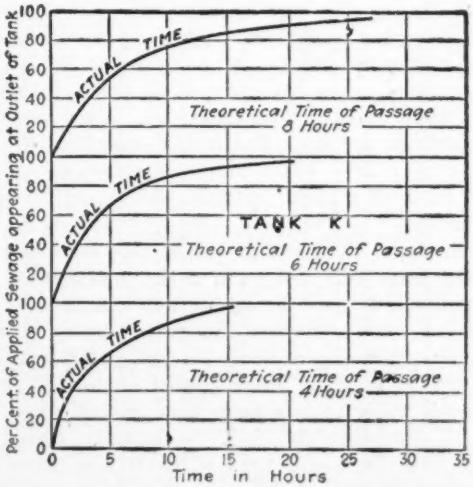

Per Cent. of Applied Sewage appearing at Outlet of Tank
Time in Hours
ACTUAL TIME
Theoretical Time of Passage 8 Hours
ACTUAL TIME
TANK K
Theoretical Time of Passage 6 Hours
ACTUAL TIME
Theoretical Time of Passage 4 Hours

FIG. 2. ACTUAL TIME OF SEWAGE FLOW THROUGH SETTLING TANK IS FAR BEHIND THEORETICAL

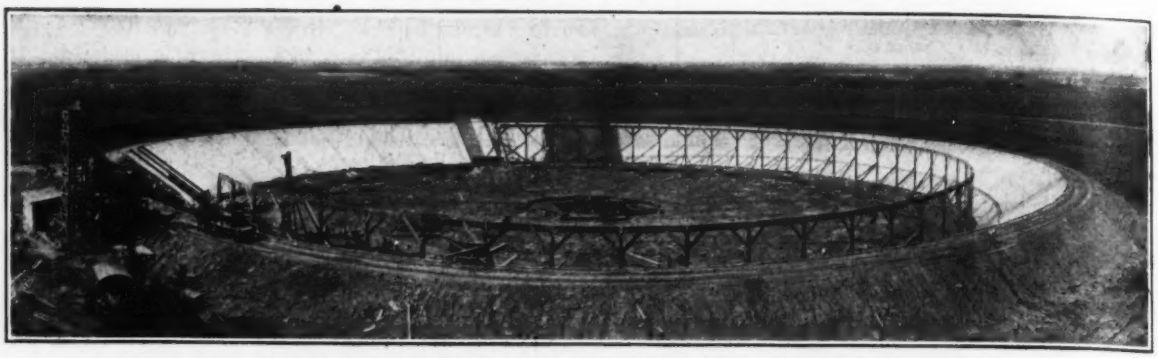
mass and is a definite number of hours in passing, instead of passing in the manner here illustrated—that is, as a progressive mixture.

Further studies, to show the effect of baffles and different arrangements of baffles in both the quiescent tanks and the tanks agitated with air, are being made in order to determine if possible a method of baffling which will cause the entering sewage to pass through with as little mixture with the held liquid as possible.

Circular Earth Embankment Lined with Concrete Forms Oil Reservoir

Type Originated in California—Introduced in Texas Oil Fields on Account of Lack of Steel — Concrete Roof Carried On Wood Frame Also Because of Scarcity of Structural Steel for Supports

By E. D. Cole
Resident Engineer, Empire Gas & Fuel Co., Bartlesville, Okla.



RESERVOIR UNDER CONSTRUCTION WITH SLOPES PAVED AND ROOF STARTED

OIL-storage reservoirs in the Texas oil fields have usually been of the steel-tank type, but the current shortage of steel led the Empire Pipe Co. to adopt for its new 350,000-bbl. reservoir at Gainesville, Tex., a concrete-lined earth embankment of the general type used to some extent in the southern California fields.

The reservoir consists of an earth embankment 12 ft. wide at the top and with 1½ on 1 side slopes forming an annular ring of 326 ft. bottom diameter and 392 ft. top diameter. Its inside depth is 22 ft. and the outside height of the embankment about 17 ft., as the fill was made from a 5-ft. excavation in the reservoir to a limestone stratum. The inside slope and the floor are covered with a 3½-in. lining of concrete, and the roof consists of a 2½-in. concrete slab on timber posts and girders.

Stability and tightness of the ground on which the reservoir was built were the first considerations in construction. A good limestone was struck at about 5-ft. depth, and overlying the rock was a layer of yellow clay carrying a small percentage of limestone gravel. This material when packed or tamped would not absorb water to any perceptible extent. The surface soil, approximately 1½ ft. in thickness, was black adobe. The site was cleared of grass and roots, and the fill was started on the compact yellow clay underlying the adobe.

The embankment was built up by fresno and wheel scrapers in horizontal 3-in. layers from material excavated in the pit. Water was used freely both in the pit and on the fill, and further compacting was carried on by means of a petrolithic road roller, disk harrow and road grader that were operated continuously around the top of the fill. Mules were used in preference to horses, being better adapted to this class of work, and the continuous tramping of their small feet very materially assisted in building up a solid and compact fill. Upon the completion of the main portion of the embankment the inside slope was lined with a 2-ft. layer of selected clay bonded to the main bank and compacted in a similar manner.

The floor of the reservoir was excavated to a depth of 1 ft. below grade and back-filled with selected clay. In places, limestone was struck within a few inches of floor grade, and this was also excavated to the same depth. The clay blanket on the floor and inside slope was placed to furnish a uniform backing for the concrete lining and to protect the concrete from cracking due to any slight settlement that might take place.

The floor and the slope were covered with a 3-in. lining of concrete reinforced with one layer of wire mesh. In the floor slab a 6-in. square mesh was used, made up of No. 6 wire each way, while in the slope slab 4-in. square mesh, made up of No. 8 wire each way, was used.

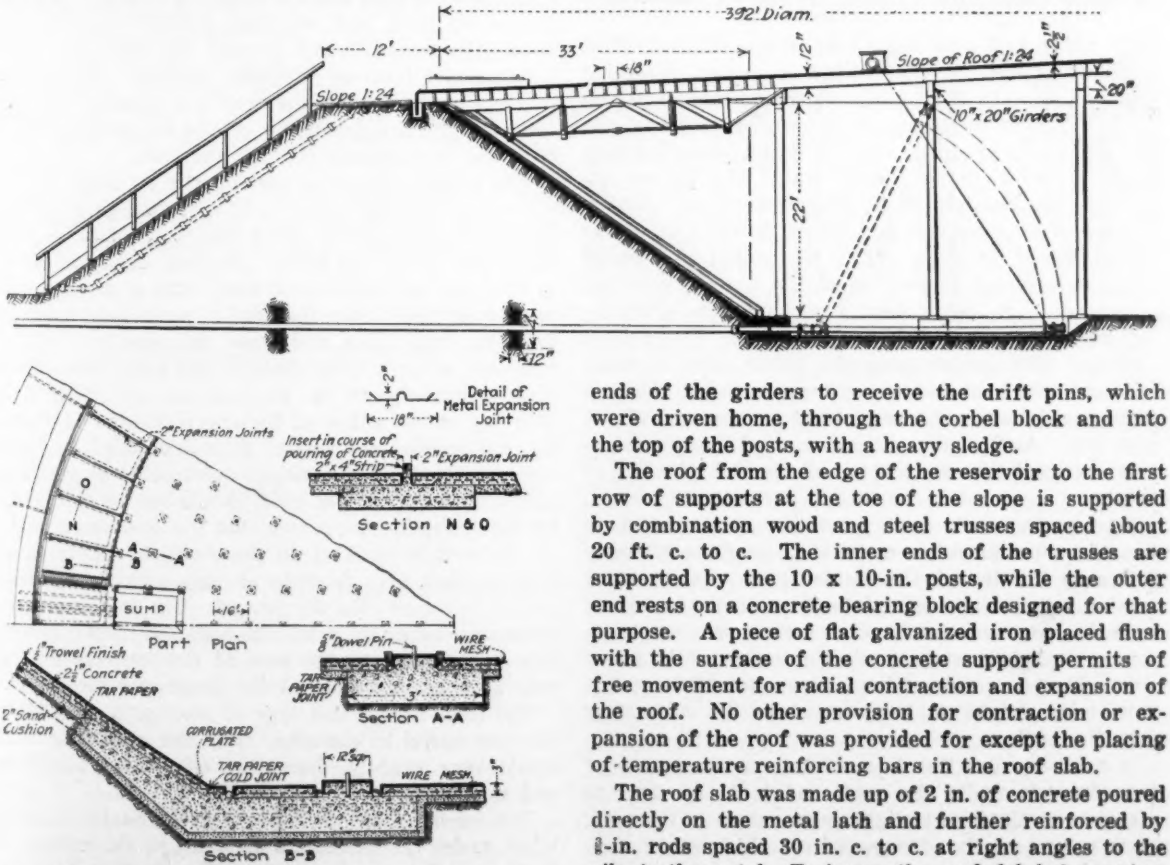
The concrete lining received a finish coat of rich cement mortar ½ in. in thickness. A 2-in. cushion of sand was provided as a backing for the concrete lining, both on the floor and the slope, the object of the sand being to provide good drainage back of the slab and to protect the concrete from a slight settlement or swelling of the embankment. This sand cushion is a very necessary feature of the construction, for the clay that makes up the bulk of the embankment is of such a nature that it cracks badly when the moisture leaves it, and consequently swells when wet. The placing of a thin slab of concrete directly on such soil is therefore poor practice, and should always be avoided. A 2-in. drainage line was laid across the floor of the reservoir and about 10 in. below the level of the sand cushion, to carry away any water that might collect, and thus do away with the danger of pressure against the concrete lining from below due to water uplift. This line connects with three gravel wells or sumps 24 in. square by 18 in. deep and filled with screened gravel. A 2-in. open nipple 6 in. long extending down into each gravel

well and covered with fine sand screen serves as a connection to the drainage line.

The concrete was mixed in a 1-cu.yd. batch mixer stationed at the foot of the slope on the outside of the embankment, and the mixed concrete was delivered into a hopper, at the toe of the inside slope, by means of a hoisting tower and chute. From the hopper the concrete was distributed over the floor with concrete buggies. The finish coat was mixed in a 4-cu.ft. batch mixer and applied immediately after the main slab was poured. No expansion joints were provided in the floor except where the slab joined the concrete column supports. At this point a 1-in. shrinkage space is provided around each support, and a 10-in. strip of corrugated iron is embedded in the support and the center of the floor slab to cut off oil seepage. The entire floor received a carefully troweled sidewalk finish.

The concrete for the slope was poured without the use of forms, as the mixture was delivered dry enough to hang together on the slope but still plastic enough to be struck off by vigorous use of a straight-edge. Expansion joints in the slope were provided every 30 ft., and each slab between joints was made at one pouring. In this way all cold joints were eliminated. The joints were made up of a piece of galvanized iron 18 in. wide embedded into the edges of the main slab and supported by an underlying slab of concrete 30 x 6 running radially up and down the slope. The expansion groove, 2 in. wide, above the galvanized iron was filled with a plastic compound insoluble in oil. The function of this filler is to protect the galvanized iron from being attacked by the oil and also to safeguard doubly against any seepage of oil around the edges of the iron. The slope lining received the same carefully troweled finish coat as the floor.

The roof as originally planned was to be of reinforced concrete throughout and designed to carry a load of 100 lb. per square foot. This plan was abandoned, however, due to the excessive cost. Structural steel was then considered as a substitute, but was abandoned in favor of wood, on account of the uncertainty of steel deliveries. As built the roof consists of a 2½-in. slab of concrete reinforced with a layer of metal lath supported on 2 x 12-in. wooden rafters spaced 20 in. c. to c. The rafters were placed radially out and were supported by 10 x 18-in. girders and 10 x 10-in. posts. The posts were spaced 16 ft. c. to c. and in concentric circles around the floor of the reservoir. The pier supports for the posts were of concrete 14 in. square and 8 in. in thickness. A ⅝-in. dowel pin placed in the top of each small pier centered and stayed the bottom of the posts. A 6 x 10-in. corbel block 24 in. long was spiked to the top of the posts to furnish proper bearing for the girders. The ends of the girders were beveled to conform to the degree of curve or circle in which they were placed. The ends were butted together and tied to the posts by two ⅝-in. dowel or drift pins 30 in. long. Holes were bored through the ends of the girders to receive the drift pins, which were driven home, through the corbel block and into the top of the posts, with a heavy sledge.



OKLAHOMA OIL RESERVOIR FORMED BY LINING CIRCULAR EMBANKMENT WITH CONCRETE

The roof from the edge of the reservoir to the first row of supports at the toe of the slope is supported by combination wood and steel trusses spaced about 20 ft. c. to c. The inner ends of the trusses are supported by the 10 x 10-in. posts, while the outer end rests on a concrete bearing block designed for that purpose. A piece of flat galvanized iron placed flush with the surface of the concrete support permits of free movement for radial contraction and expansion of the roof. No other provision for contraction or expansion of the roof was provided for except the placing of temperature reinforcing bars in the roof slab.

The roof slab was made up of 2 in. of concrete poured directly on the metal lath and further reinforced by ⅜-in. rods spaced 30 in. c. to c. at right angles to the ribs in the metal. To insure the roof slab being watertight, a ½-in. layer of cement mortar was poured on

the top of the slab and an asphalt and gravel roofing applied. A layer of gunite was placed on the under side of the roof, primarily to protect the metal lath from attack by moisture or gas escaping from the oil. It also serves to make the roof gas-tight.

The concrete slab at the edge of the roof was carried over the ends of the rafters and down within 3 in. of the bottom of a concrete ditch placed just outside of the mudsill and extending all the way around the top of the embankment. This ditch is 18 in. deep and 12 in. wide, with walls and bottom 4 in. thick and reinforced with a layer of wire mesh. Expansion joints were provided every 25 ft. Water 9 in. deep is maintained in the ditch, which provides a 6-in. head of water against the gas pressure within the reservoir.

PART OF TIMBER ROOF HAS BEEN PUT ON RESERVOIR

This water seal was devised by J. J. Allinson, chief engineer of the company. Six-inch sewer-tile drains laid just beneath the surface of the embankment lead from the ditch and serve to carry storm water from the roof of the reservoir and also to maintain the 6-in. head of water in the water seal. The drains are spaced approximately 50 ft. apart around the circumference of the reservoir and extend to the foot of the outside toe of the slope. Three 8-in. outlet or draw-off pipes were placed in position at the beginning of the earthwork 2 ft. below floor grade and extending the full width of the embankment at this level. Swing pipes equipped with special swing-pipe joints serve to drain oil from any level desired. These pipes are operated from gas-tight winch boxes placed on the roof of the reservoir. An 8-in. filling line is carried into the reservoir over and through the top of the embankment, as shown.

Two gaging wells were provided. They consist of two 8-in. pipes placed on opposite sides of the reservoir and near the toe of the inside slope. They extend vertically from the roof to the floor of the reservoir, with the lower ends of the pipes resting on a ½ x 18-in. square steel plate set to the floor elevation of the reservoir. The lower ends of these pipes contain four slots 2 in. wide and 36 in. long, to permit the oil to flow into the wells.

A 3-in. dry gas line is carried in to the center of the reservoir under the roof, and is to be used to maintain at all times a slight gas pressure in the tank, so as to prevent the entrance of air which might form an explosive mixture. A 4-in. wet gas gathering line is supported on the second rows of posts toward the center from the toe of the slope and 18 in. above the oil level when the reservoir is full. This line follows this row of posts all the way around and is connected at a common header with a 6-in. line leading out from the reservoir through the top of the embankment. An open 4-in. T looking down was placed every 100 ft. throughout the length of the 4-in. line to allow free entrance of the gas and also to prevent the formation of pockets of condensed gas. Each of these gas lines leads away from the reservoir on a uniform grade underground to a small gas-regulating house above 200 ft. outside the fire wall. Both lines are provided with water drips to draw off any water or condensed gas that may collect in the line.

To protect the reservoir from being set on fire by lightning the following precautions were taken:

The reinforcing metal in the roof slab was made everywhere continuous by overlapping and wiring together at frequent intervals, and at points about 20 ft. apart around the outer rim of the tank the reinforcing metal of the roof and slope slab were tied together with No. 9 galvanized wire, using soldered connections. All pipe lines leading into and from the reservoir beneath the roof were connected to the roof reinforcement in a similar manner. The object of the wiring was to furnish an easy path for the discharge of the earth electrical field during a storm, and in this way prevent a short circuit or spark that would ignite the gas underneath the roof. With the above installations there is a double safeguard against lightning attack. The gas-regulating lines will maintain a slight gas pressure inside the reservoir and prevent the entrance of air which would form an explosive mixture. The wiring together of the reinforcing metal will provide a continuous path for the grounding of the accumulated earth electrical field passing through the tank.

The popular theory to explain why oil tanks are set on fire by lightning seems to be that the lightning flash ignites escaping gases above the roof, which in turn ignite the oil in the tanks. Another theory advanced is that the ordinary steel tank with a wooden roof is so constructed that the roof is practically insulated from the steel sides, and when the tank is struck by lightning a spark takes place on the under side of the roof, setting fire to the gas and the oil in the tank. Whether or not either of the above theories is correct the writer does not know. It is his belief, however, that a concrete-lined reservoir constructed as described above, with a gas-tight roof, should not be set on fire by lightning, for the reason that the reinforcing metal in the roof as well as in the reservoir lining is all tied together, thus forming an easy path for the electricity to escape into the ground. The insurance companies also entertain some such belief, as their insurance rate against fire in the case of the concrete tank is only 25% of that charged for insuring a steel tank.

The total cost of this type of storage is from 32 to 35c. per barrel of capacity. The cost of similar work would vary slightly, depending on ground conditions and weather.

The construction work was carried on by company labor, under the immediate direction of the writer. J. D. Hackstaff is manager of the Empire Pipe Line Co., and J. J. Allinson is chief engineer, with headquarters

at Bartlesville, Okla. Acknowledgment of valuable assistance is made to the firm of Dodd & Struthers, Des Moines, Iowa, under whose direction the wiring to safeguard the reservoir against lightning attack was carried out.

Principles on Which the French Highways Are Built

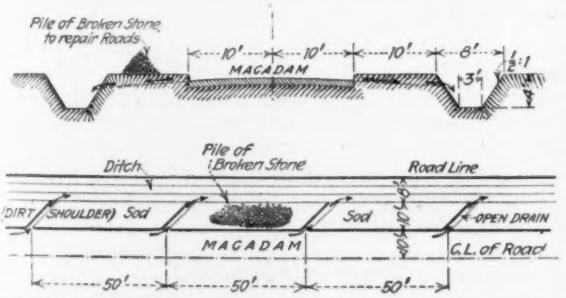
Roman System of Direct Lines Between Strategic Points Followed—Great Attention Is Given to Drainage

By Frank W. Harris
Captain of Engineers, United States Army, American Expeditionary Forces

FRENCH practice in the location and construction of roads follows in general four principles—that all roads between trade centers and fortresses shall be straight; that all construction shall follow the general contour of the ground, the limiting grade being probably 8%; that an adequate drainage system shall be worked out at the time of building the road, and that a macadam surface shall be applied. These roads are located for purposes of war as well as peace, and the old Roman military idea that roads between strategic points in the empire should be straight is still followed.

In all parts of France the roads are very solid, and after years of war use are in good shape in all sections back of the lines. The main reason for this is the good drainage provided. The plan and cross-section views show the construction of a typical French road. The side slopes vary with the soils, and the years have worn them in all manner of shapes. There is therefore no fixed ditch section. The dimensions vary along the same road, but the general principles shown are pursued.

Wide dirt shoulders and a low crown are the rule, and the side drains running across the shoulders show ingenuity and are very important. The sodded spaces



FRENCH HIGHWAYS HAVE SPECIAL DRAINAGE SYSTEM

between them are used for piling broken stone ready for making repairs. The roads are maintained and repaired on the old idea that a stitch in time saves nine.

French engineers build their main roads, as stated above, in a straight line between trade centers, the roads following the natural surface of the ground, so that it is unusual to see very heavy cuts or fills on the highways. While this frequently results in short stretches of grade up to 8%, it shortens the distances between trade centers, the surface of the road is hard and good, and the grades have not proved serious obstacles to the heavily loaded army trucks.

In the United States we have been dominated by the railroad idea of low grades in highways. This idea, while good, has often been carried to extremes, with the result that it has cost us too much for grading. Under conditions of modern motor-truck transportation, where any grade up to 6% or even 8% in special cases is permissible, we shall get better road-building results if we increase the rate of grade and spend less money making heavy cuts and fills. The money saved in grading can be invested in larger and better side drainage is discussed, but there the matter often ends.

In all road textbooks and at good-roads conventions, drainage is discussed, but there the matter often ends. Our modern roads are a modification of a railway roadbed, and our ditches are the old track ditches. We have not yet adopted a real highway section, largely due to the fact that railroad engineers designed the sections in use on our new roads. It can be seen easily that the adoption of such a section as is shown in the illustration would add at least 25% to the cost of construction, unless we modified some of our highway location and construction theories.

World Port for Shanghai Planned By Conservancy Board

Authorities Make Study of Scheme Whereby Whole River Is Converted Into Tidal Dock to Float Largest Vessels

POST-WAR trade development which would make China an important factor in the world's commerce is anticipated in a recent report on the proposed port works of Shanghai by the Whangpoo Conservancy Board, the body that controls the port. The report frankly looks far into the future, for it plans a port to take care of vessels drawing up to 50 ft. of water, and contemplates a total expenditure of nearly $100,000,000 over two decades. But the commercial conjectures of the engineers are interesting to all shipping men, particularly those on the Pacific Coast, and the engineering design of the new port is bold beyond any previous similar project.

The report is entitled "The Future Development of the Shanghai Harbor" and was prepared by H. von Heidenstam, a Swedish engineer who is engineer-in-chief of the Whangpoo Conservancy Board, acting jointly with the Hydraulic Engineering Bureau of Stockholm, represented by J. G. Richert and P. G. Hornell. It is accompanied by a lucid commentary by W. F. Tyler, coast inspector, Chinese Maritime Customs.

It is the contention of the authors of the report that the time is fast arriving when Asian industry and demands will build up a tremendous commerce. The conclusion is reached not only from a belief in the early industrial growth of the Chinese people, but also by the increased facilities of transportation from Europe and the eastern coast of America to China through the Panama Canal. This canal has not had time to demonstrate its effect on world commerce, because of the restrictions of the great war, but in the

post-war period will undoubtedly have a pronounced influence on trade. Particularly, in the views of the authors, will this affect the Pacific Ocean, which to their minds will be the scene in the next twenty-five years of the greatest maritime growth in the world. Of interest to Americans is their conclusion that a large part of this new Pacific trade will be between both coasts of the United States and China. Whether this will be carried in foreign or American bottoms is not part of their investigation.

Looking Ahead Fifty Years

On the basis of such assumptions as to world trade, the port engineers demonstrate to their own satisfaction that Shanghai is the proper port to which most of this new trade will come, and should, therefore, be developed to take care not only of the ordinary tramp steamer traffic, but also the largest types of ocean vessels which, as has been demonstrated in the past, can be made commercially successful only when traveling on stabilized routes. The authors go so far as to assume that the day is not too far distant when steamers as large as or larger than those now plying the transatlantic route will make regular sailings between Pacific Coast and Chinese ports. This means, in their view, that a port designed for fifty years to come must have at least a 50-ft. draft at deep water.

To bring about such a port at Shanghai requires a radical engineering design. Shanghai is on the Whangpoo River, which is a tidal estuary of the Yangtsze and empties into the latter about 15 miles below the center of the city. The proposed project consists in closing the mouth of the Whangpoo with a dam carrying lock gates, thus transforming the whole Whangpoo River into a continuous dock harbor with a water level corresponding to the mean water level at the mouth of the Whangpoo.

Details of the Project

The width of the river crossing which will have to be dammed is not given in the report, but on a small-scale map accompanying the report it is about one mile. Subsidiary details connected with the project are the building of training walls to increase the depth of the approaches to the river, the rearrangement of the sewage disposal and water-supply of the city, which now are tied up to the tidal estuary, and the construction of quays along both sides of the fixed-level river which would be established by the construction of the tidal locks. Contributing difficulties may be found in the control of the Yangtsze estuary, which is one of the largest river mouths in the world and is not entirely stable.

The report, while most elaborate, is presented merely as a preliminary to suggested investigations which are necessary for a more detailed study of the plan. The authors state that in the Yangtsze valley contributory to Shanghai there are living 170,000,000 persons, or about one-tenth of the inhabitants of the earth. It is their claim that these people are about to enter into a great industrial development, and that an attempt must now be made to plan for the next fifty years, to take care of the expected increased commerce which this development will entail.

Water-Works and Sentiment

NOT often is there much sentiment connected with the water-works business. Not often does the citizenry look upon its water-works structures with reverence. However, the real old Chicagoans are up in arms over the proposed removal of the Chicago Ave. water-works tower, which is as much identified with old Chicago as Faneuil Hall is with Boston or the Tower of London is with London. The tower is in the line of the roadway of the greatly widened Michigan Ave. Boulevard link improvement. The Board of Local Improvements proposes to move it back 50 ft., and "if in doing so it happens to fall it will not be built up again," says the president of the board.

The protests aroused by the plan have called forth the following comment in the Chicago *Tribune*, addressed to the president:

"Mr. Faherty, you're a good citizen, with excellent impulses, but you only arrived in Chicago in 1888. What does Chicago's past mean to you? What visions are there in your mind of the young, ardent, ambitious city which directly after the Civil War undertook civic improvements far more important to its time than any you are now fostering? Do you realize the satisfaction with which they contemplated the finished power house in 1866, and the overwhelming pride that filled their bosoms when they gazed upon the completed tower, which soared above the miles of comfortable, prosperous, little homes stretching to west and north?

Recalls the Big Fire

"Were you one of the fleeing multitudes who on Oct. 9, in 1871, saw the tower standing, a solid white shaft, amid whirling flames that devoured every other structure for miles? Was your youth spent in its shade as the new city sprang up out of the ashes in the seventies and eighties?

"The architect of the water-works and the tower, W. W. Boyington, was a great man in his time. He came here from New York in 1853 and designed practically all of the principal buildings of his era. The old Chicago University buildings, including the then famous Dearborn Observatory, were his work, and, like the water-works, were built of solid, rock-faced ashlar stone from Vermont, in what was then called castellated Gothic style.

"In the years immediately following the fire he was the architect of $2,500,000 worth of buildings. So he was a man of importance here.

Tower or Residence?

"The present proposition is to move the tower back so as to allow the new boulevard to end its extreme width at Pearson St., leaving the quondam J. V. Farwell house as the chief object in view. Now, in its day, the Farwell house was considered a fine example of domestic architecture, but, as an alternative to the water-works tower for an effective bit of street-end building, it isn't in it with the tower.

"Knock down, if you will, old homes, old houses, old landmarks, but spare that 154 ft., of white, gleaming shaft, whose turrets and crenelated battlements mean so much to so many people."

Some Heavy Fitting-Out Cranes—II. Cantilever and Jib Travelers at Newark Bay and Bristol

Double Cantilever Bridge Traveling Along Pier Commands Line of Ships on Either Side—Provision for Extension—Friction Draft-Gear Buffers—Tower Jib Crane Fitted with Special Safety Devices

[*Passed by Publication Approval Committee, Emergency Fleet Corporation*]

CONTRASTING sharply with the fixed derrick and bridge cranes of Kearny and Hog Island, described last week and shown by Figs. 1 and 2 herewith, travelers are used at Newark Bay by the Submarine Boat Corporation, and at Bristol by the Merchant Shipbuilding Corporation, for heavy service at the fitting-out dock.

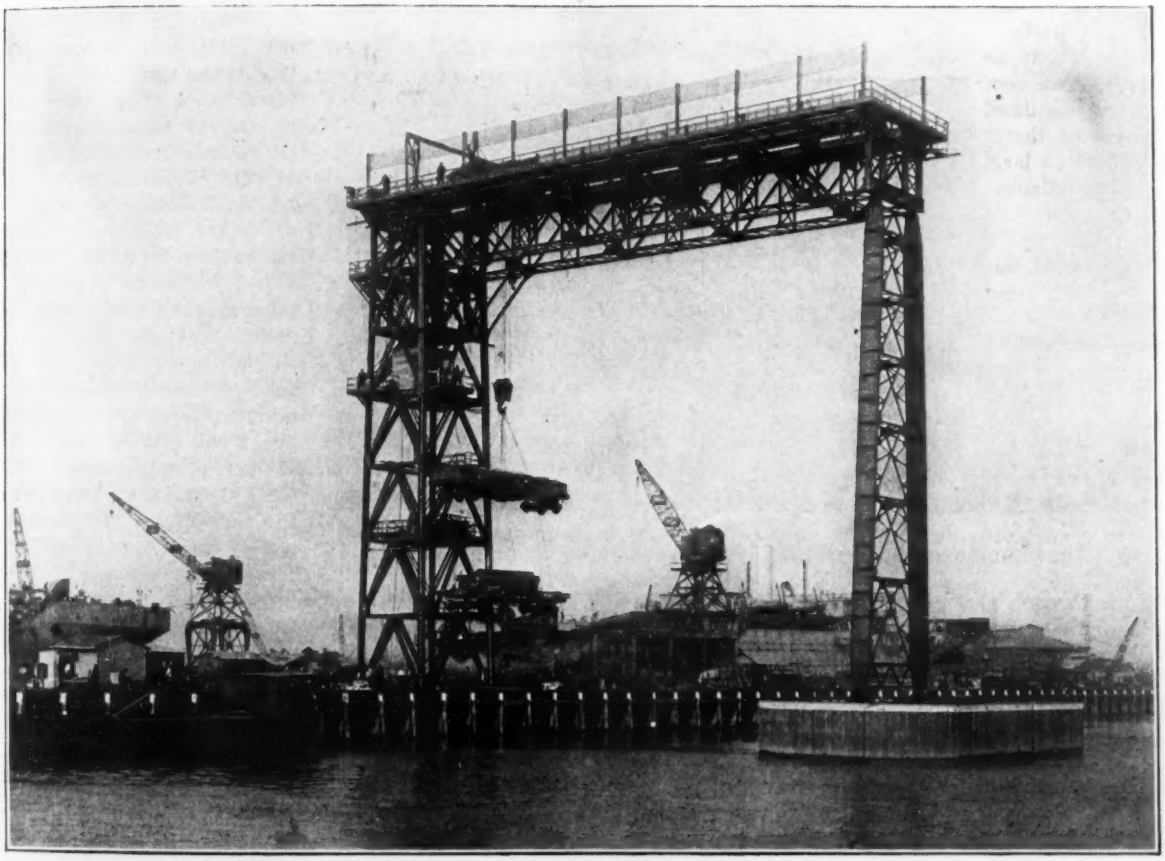


FIG. 1. HOG ISLAND FITTING-OUT PIERS HAVE A FIXED CRANE BRIDGE OF 100 TONS CAPACITY AND SMALLER TRAVELING GANTRY JIB CRANES

The Newark Bay machine travels along a pier and commands ships on either side. The Bristol crane serves riverside dock frontage only. This latter machine, while specially designed in all respects, is of well established type; the Submarine Boat Corporation's double cantilever bridge, on the other hand, is a machine as original in type and details as it is impressive in its general appearance, shown by Fig. 4.

Travelers were adopted at both yards in order to save the trouble and delay of moving the ship into position under a fixed crane. The requirements of the work are not essentially different from those prevailing at yards using fixed machines, whether of the type described in our previous article or of the shear-leg type popular on the Great Lakes. It was believed, however, that with machines able to move along to the ship it would be possible not only to gain time in placing boilers, engines and the few other parts of great weight comprised in the ship equipment, but also to do some of the lighter installation work, in order to supplement the service of the smaller machines provided for this work; maximum flexibility of the whole fitting-out plant was aimed at.

General dimensions and some essential structural features of the Newark Bay cantilever traveler are given by the drawing Fig. 3. The crane, running on two narrow-gage tracks spaced 41 ft. between centers, operates along a pier about 60 ft. wide by 702 ft. long, and straddles a set of railroad tracks extending the full length of the pier and connecting at the land end with the yard track system. All material is brought out by way of these tracks, and the crane trolley must pass

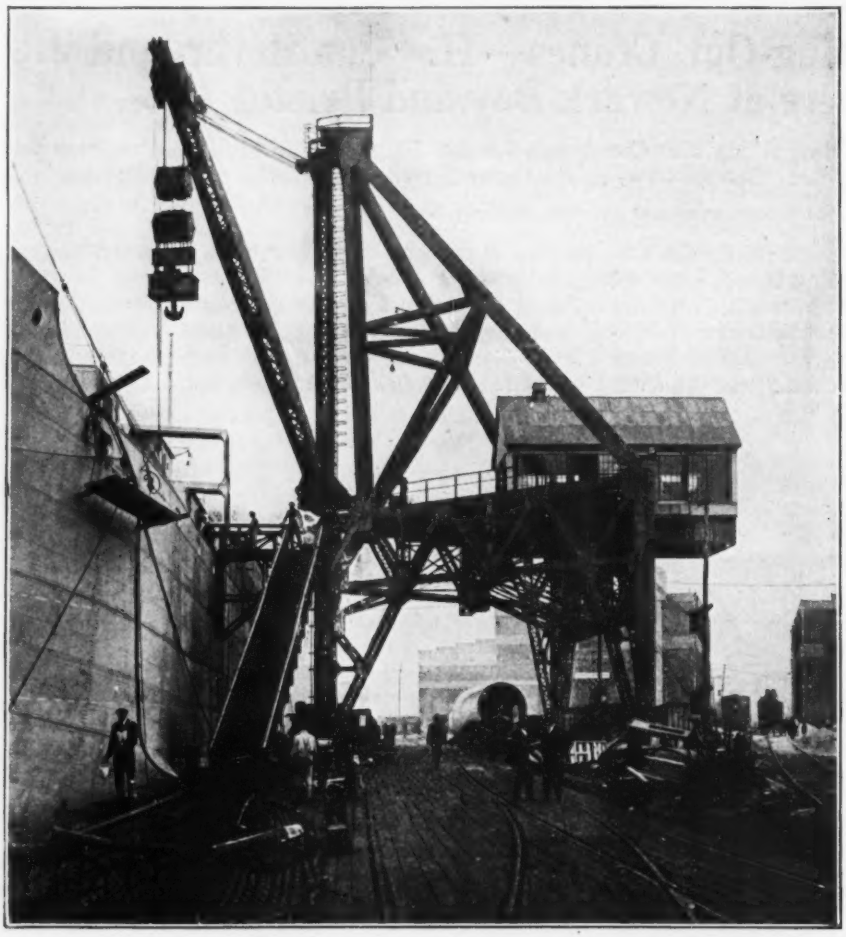


FIG. 2. HEAVILY BRACED TRIANGULAR PLATFORM CARRIES 100-TON PILLAR-CRANE DERRICK IN KEARNY YARD OF FEDERAL SHIPBUILDING COMPANY

it out through the space between the gantry legs in transferring it to the ship. For this reason, though the legs are tied by a deep and rigid tie strut near the bottom, the space above this is not encumbered by bracing.

Very heavy construction characterizes the machine, but apart from the interesting manner of framing and the make-up of the tower legs the arrangement is simple enough to require no description. The superstructure is a simple bridge supporting a pair of suspended track beams for the crane trolley. This latter is a 50-ton trolley built by the Morgan Engineering Works. Its winding drums are placed transverse to the track; they had to be made unusually long to take care of the great height of lift required, which accounts for the wide spacing of the tracks.

Special study was given to the design of the trucks which carry the crane. Because the pier structure contains three piles in a closely spaced bent under each track, a two-rail track on either side of the pier was adopted, as distributing the track load better than a single rail. Each leg is carried by two four-wheel trucks. A heavy truck girder of box section rests on the truck frames by cast-steel ball-and-socket bearings; links attached to lugs of the upper and lower halves of these bearings, two on each truck, tie the structure together against chance disjointing. The tower leg engages the truck girder by means of a transverse pin through the girder webs, the leg being formed into a strong fork or jaw passing outside of the girder to take the pin. The pin is located at mid-length of the girder, but is near the inner edge of the tower leg, so as to bring the vertical reaction as near as possible to the center-line intersection of the tower leg and the lower member of the fore-and-aft tie, and thus minimize the bending in the tower leg. One of the two trucks of each tower leg is driven. There is a separate motor at each of the four driven trucks, geared to both of the axles of this truck. All motions of the crane are controlled by automatic acceleration switches; this is to eliminate risk of accident from operator's negligence or error. The speeds for which the crane is designed are as follows: Main hoist, 10 ft. per minute; auxiliary hoist, 40 ft. per minute; trolley motion, 40 ft. per minute; crane travel, 150 ft. per minute. At the ends of the crane tracks and of the trolley track, buffers are provided to stop the machine or the trolley without sudden impact. Friction draft gears were used as shock-absorbing elements in these buffers. Thus, in the construction of the buffer at the end of the crane track, oak striking plates at the front of a timber crosshead receive the impact of the crane wheels; the crosshead is held to the rails by nuts on through bolts of the buffer timbers engaging the under side of the rail head. Directly back of this crosshead are mounted two Westinghouse friction draft gears in series, held in position on a timber base and backed by an anchor block securely fastened to the bent-up ends of the crane track rails.

A shown by the drawing, Fig. 3, the crane is intended to have an ultimate reach sufficient for serving two lines of boats on either side of the pier, which will take care of eight boats at one time. Normal working conditions do not require so large a capacity, however, and for present service the crane has been built only to half reach on either side, as is indicated in Fig. 3, and more definitely shown by the view, Fig. 4. In its present condition the structure, trucks and machinery weigh about 700,000 lb., which, with the trolley weight of 78,000 lb., makes a total of about 780,000. In its completed condition the crane will weigh roughly 1,000,000 lb. Its cost at half length is $134,000.

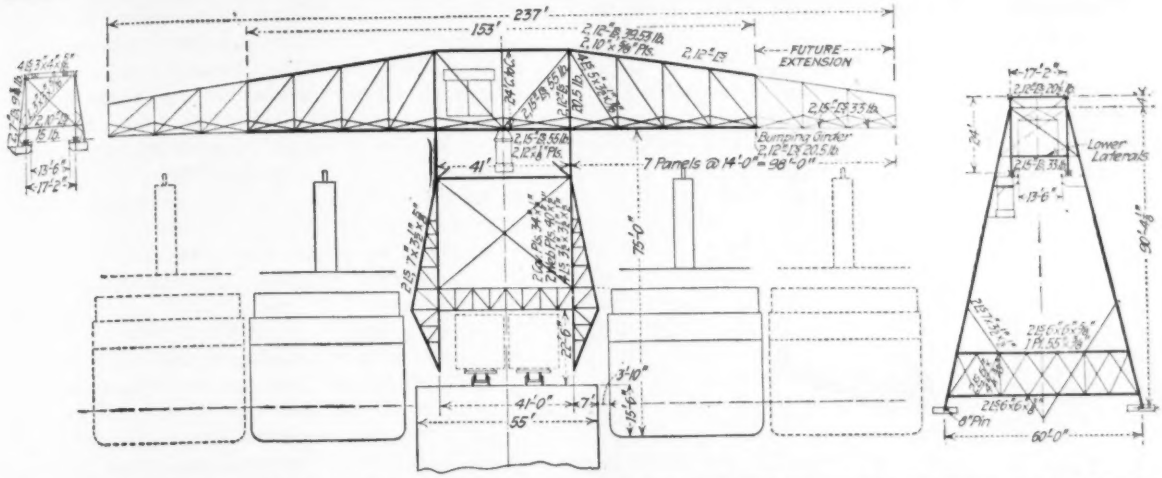


FIG. 3. STRUCTURAL DIAGRAM OF THE NEWARK BAY CANTILEVER TRAVELER—ULTIMATE EXTENSION OF THE BRIDGE AS INDICATED WILL ENABLE IT TO COVER TWO LINES OF SHIPS ON EITHER SIDE OF THE PIER

Light fitting work at Newark Bay is handled in a separate location as well as by separate machines. The pier with the cantilever crane is devoted to heavy work exclusively; this pier projects out from the main yard front into the waters of Newark Bay as an extension of a marginal dock which forms the south boundary of the yard, fronting on a channel or slip extending inland about 2700 ft. along this side. This dock is used for the light fitting work. Its equipment comprises a three-track railroad along the length of the dock, and a trestle for locomotive cranes between the tracks and the face of the dock. Three long-reach locomotive cranes operating on this trestle handle the ship-equipment material from the supply tracks to the ships lying along the wharves.

With the length of slip and dock available, 18 of the Submarine's 5000-ton ships can lie along the dock, in two lines. With the same double-line arrangement the heavy fitting-out pier accommodates eight ships, making a total capacity of 26. It is not expected that this will be normally required. The estimates are for 21 ships undergoing fitting-out simultaneously, four at the heavy pier and 17 along the trestle. This estimate is based on a fitting-out period of 45 days.

The trestle is about 30 ft. high by 14 ft. wide. It carries a track of 16-ft. gage for the main locomotive cranes which do the fitting-out work. A standard-gage track has also been laid on the trestle, to take ordinary locomotive cranes (with outriggers bearing on the two outer rails for stability).

Noteworthy innovations were introduced in the design of the locomotive cranes, based on the experience of the steel-erection men in the engineering department of the Submarine Boat Corporation. The cranes each have four single-drum winches in the cab, handled by separate controllers, and thus avoid the use of clutches so common in all forms of hoisting machinery. Each winch is a simple grouping of motor, gears and drum in a frame, generally with a solenoid brake on the motor shaft and an emergency foot-operated brake on the drum. The winches handle respectively the main hoist, the auxiliary hoist, the topping lift and the swing. The swinging motor has no solenoid brake, as this would be likely to give too abrupt a stop and tend to cause the load on the hook to swing. Two diagonally opposite trucks of the machine are equipped with separate motors for the travel of the machine. The two motors are handled by one controller, making the fifth controller in the cab. These motors have a solenoid brake only.

A five-part main hoist and a single-line auxiliary hoist are used. The winches are designed to give about 180 ft. per minute speed with a 25-hp. motor, under normal load conditions. The travel speed of the crane is about 175 ft. per minute. The hoist hooks are swiveled on ball bearings, which in practice give very easy rotation of the load.

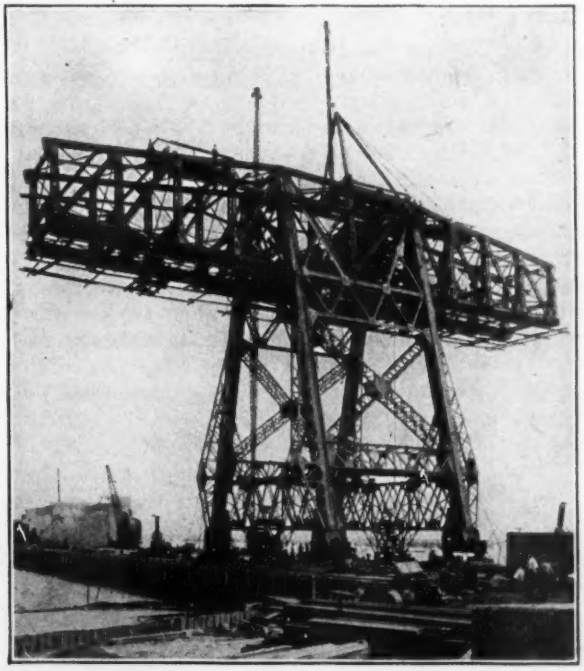


FIG. 4. NEWARK BAY 50-TON CANTILEVER TRAVELER DURING ERECTION

A boom length of 90 ft. was adopted, to enable the crane to reach out over two ships abreast. The lifting capacity is 10 tons at 50-ft. radius and 4 tons at full 90-ft. reach. A high A-frame and a counterweight raised high enough to pass over the rail of the ship at maximum stage of the tide are features of the structural arrangement of the crane. The machines were built by the Industrial Works, Bay City, Mich.

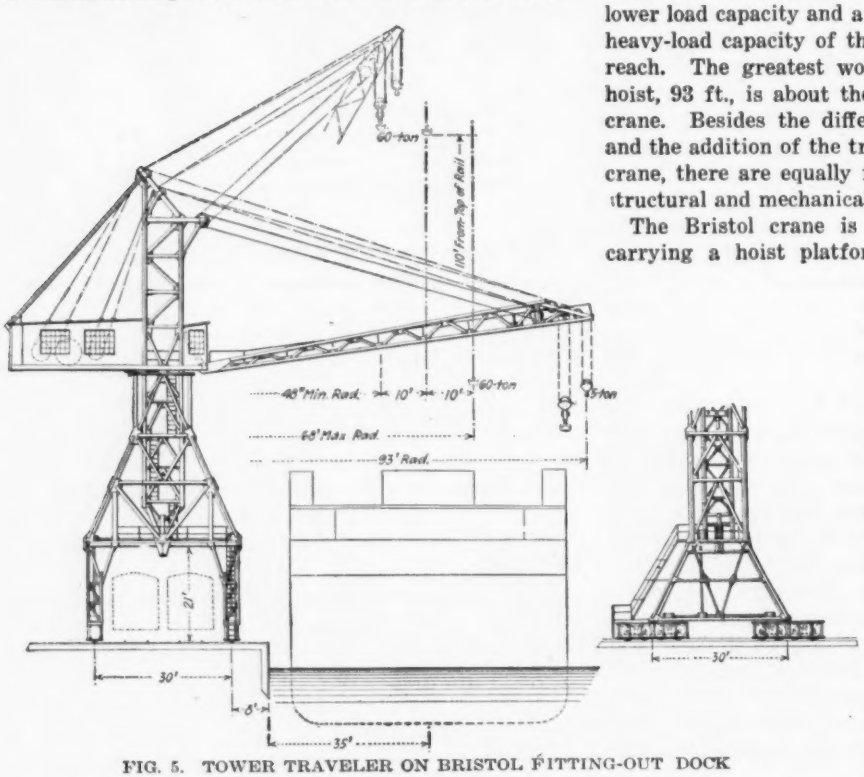


FIG. 5. TOWER TRAVELER ON BRISTOL FITTING-OUT DOCK

In contrast with the fixed cranes of Hog Island and the Federal yard, the managers of the Merchant Shipbuilding Corporation gave preference to a traveling crane for equipping their yard at Bristol, Penn.. The problem presented there was very closely like that at Kearny, since both yards have 12 shipways and carry on their fitting-out work alongside an ordinary dock wall. Furthermore, the ships built at the two yards are of about equal size (9000 and 9600 tons capacity). In spite of the similarity of general requirements the solution with respect to the crane equipment differs radically.

Bristol, besides choosing a traveling crane, fixed a lower load capacity and a smaller reach. The maximum heavy-load capacity of the machine is 60 tons at 68-ft. reach. The greatest working radius of the auxiliary hoist, 93 ft., is about the same as that of the Federal crane. Besides the differences in capacity and reach, and the addition of the traveling function in the Bristol crane, there are equally fundamental differences in the structural and mechanical arrangement.

The Bristol crane is of the revolving-tower type, carrying a hoist platform and boom pivot at about mid-height. The weight is transmitted from the tower to the supporting gantry through a pin seat at the base of the tower, while overturning is taken care of by eight horizontal wheels carried by the tower, bearing against the inside of a curb ring of the supporting frame. The structural arrangement of the machine is shown in Fig. 5, which also gives the main dimensions. The design of the structure for the several load conditions and wind was carried out for a working stress of 15,000 lb. per square inch tension and 13,000 (reduced by formula) compression. The stability of the machine is sufficient to provide for a wind pressure of 10 lb. on the loaded crane and about 30 lb. on the empty machine. The counterbalance at the tail of the hoisting-engine platform takes care of about half the maximum load moment, and thus gives about equal margins of stability in loaded and empty conditions.

The swinging-engine has some rather unusual features, designed to permit smoother operation. Instead of the usual solenoid brake on the tail of the motor

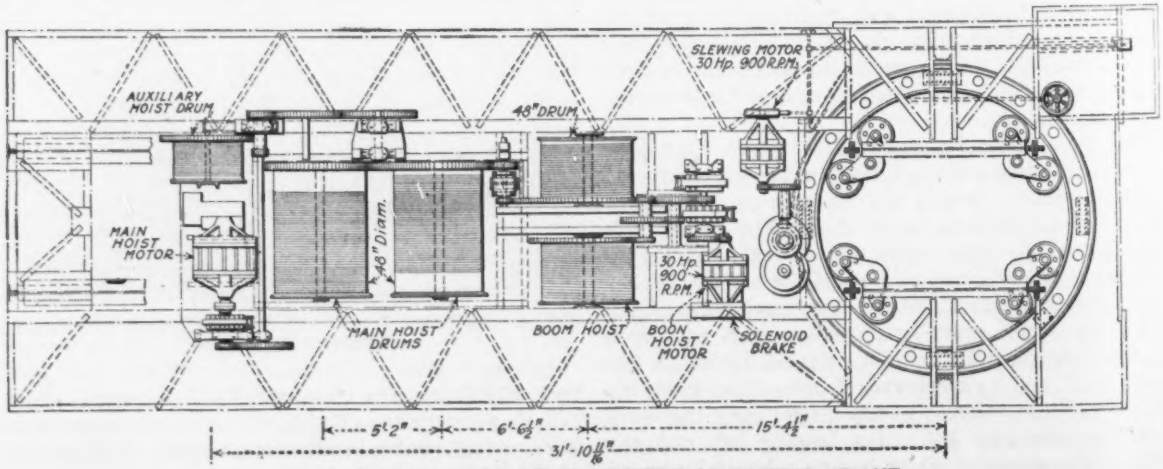


FIG. 6. THREE-MOTOR JIB MACHINERY OF BRISTOL CRANE

shaft, a hand brake was provided to enable the braking effort to be varied as circumstances may require, or to let the swinging motion coast to a stop when desired. To permit the use of an easily applied brake and yet prevent the operator from jamming it on too hard, as well as to prevent damage in case of suddenly reversing the motor, a friction drive was installed on one of the gears between the motor and the rack circle. This has an adjustable spring pressure, providing the necessary friction to accelerate or retard the crane at the proper rate, but preventing this rate from being greatly exceeded.

Interconnected hoist and boom-hoist rigging also characterizes the machine, the object of the arrangement being to limit the work of the boom hoist to changing the position of the boom, without lifting the load, in accordance with the principle first applied to derricks many years ago. The main hoisting rope is carried through the hoist block and dead-ended on the boom-hoist drum. By this arrangement the load on the hook acts as a counterweight pulling on the boom-hoist tackle, thereby tending to neutralize the effect of the load on the motion of the boom. While the boom is being raised from its extreme outer to its extreme inner position, the hook describes a flat-curved line which through most of its range does not depart far from the horizontal. When the auxiliary hoist is in use and the main hook is idle, this neutralizing action is not called for. On this account the gear-shifting mechanism which connects the hoisting motor to the auxiliary hoist drum (after disconnecting it from the main hoist drum) simultaneously connects the main hoist drum to the boom hoist, so that the operation of the boom hoist in this case carries the hook along in fixed relation to the boom.

On the reverse operation, changing the motor from the auxiliary to the main hoist drum, the gear-shifting mechanism drops a pawl into the gear of the auxiliary drum, to hold the auxiliary hook from dropping.

Safety lowering brakes are used on both the hoist motor and the boom-hoist motor. These brakes consist of alternate steel and bronze disks running in oil, and make it impossible to lower without running the motor backward. Both motions are also equipped with magnetic brakes on the motor shaft, requiring power in the circuit to release the brake and permit operation of the motor. Limit switches control the motion of the hoisting rope so as to prevent overwinding, and also make it impossible to operate the 60-ton hoist when the hook is at a radius exceeding 68 ft. The boom hoist has limit switches to prevent the boom moving upward or downward beyond definite limits of motion, and other switches to stop both hoisting and boom motions when either of the two hooks comes within a predetermined distance of the boom structure.

The operating speeds of the machine are the following: Hoist, 15 ft. per minute; maximum lifting range, 110 ft.; boom hoist, full range of motion under maximum load of 60 tons, 2½ min.; auxiliary hoist, 100 ft. per minute; swinging motion, ½ r.p.m.; traveling motion, 75 ft. per minute. Four motors operate the machine, all of them running on three-phase alternating current at 440 volts. The hoisting motor is of 75 hp. It drives either the main hoist drum or the auxiliary hoist drum, according to the position of a shifting pinion. The same motor brake and safety lowering brake serve both the main and the auxiliary hoisting drums, through this arrangement. The boom-hoist motor is of 30 hp., as is also the swinging motor. The travel motor is of 75 hp.; it has a solenoid brake.

The main hoisting rope is rigged in 12 parts between the hoist block and the end of the boom. The boom hoist has 11 parts in the tackle between the boom and the mast.

The entire machine is operated through four drum controllers.

Heyl & Patterson, Inc., Pittsburgh, designed and built the machine. Under contract taken in November, 1917, the crane was erected and ready for operation by August, 1918. Its cost was about $120,000, erected. The total weight of the crane is 190 tons.

Urges Electrification of the California Railroads

D. F. Folsom of Oil Division of Fuel Administration Points to Oil and Capital Economy—Purchase of Power

ELECTRIFICATION of the mountain divisions of California railroads has been recommended to Director-General of Railroads McAdoo by D. F. Folsom, director of the Pacific Coast section of the Oil Division of the Fuel Administration, as a means of conserving fuel oil and reducing the operating expenses of the sections of the railroads involved by $4,923,300 a year.

The recommendation, based on a report of W. F. Dietrich, engineer of the Oil Division of the Fuel Administration, shows that the electrification of 510 miles of railroad would mean an annual saving of 3,062,000 bbl. of fuel oil, the total cost of which is $6,147,000, and that the cost of power to operate the trains over these sections at 0.75c. per kilowatt-hour would be $2,000,000, indicating a reduction in the bill for motive power of $4,147,000 annually. The first cost of the electrification is placed at $23,012,000, on which there is estimated an annual profit of 9.4%, after allowing for depreciation, amortization, taxes and interest.

The railroad divisions affected by the recommendation are the Sacramento division of the Southern Pacific, 157 miles, from Roseville, Cal., to Sparks, Nev.; the Shasta division of the Southern Pacific, 215 miles, from Gerber, Cal., to Ashland, Ore.; and the San Joaquin combination division of the Southern Pacific and Santa Fé railroads, 138 miles, from Bakersfield to Saugus.

With oil valued at an average figure of $2.02 a barrel and electricity at 0.75c. per kilowatt-hour (a total of $2,000,000), the annual saving in the cost of power is $4,147,000 in favor of electrification. The purchase of hydro-electric power is contemplated throughout the report, but it is pointed out that even if the electricity were generated by oil there would be a saving of about half the consumption of oil now used as locomotive fuel. Thus 267,400,000 kw.hr. at 200 kw. per barrel would require 1,337,000 bbl. of oil, or 43.6% of the present consumption of locomotive fuel in the three districts.

COMPARISON OF OPERATING COSTS ON THE THREE DIVISIONS BY STEAM AND BY ELECTRICITY

	Sacramento Division		Shasta Division		San Joaquin Division	
	Electric	Steam	Electric	Steam	Electric	Steam
Substation labor and supply	$104,200		$73,200		$89,000	
Transmission and contact system maintenance	82,700		70,000		47,000	
Maintenance of way	490,000	$650,000	510,000	$680,000	285,000	$381,000
Locomotive repairs	260,000	390,000	230,000	461,000	194,000	388,000
Locomotive enginemen	185,000	258,000	400,000	530,000	172,200	231,900
Fuel or electricity	783,000	2,200,000	549,000	2,065,000	688,000	1,882,000
	$1,905,400	$3,498,000	$1,832,000	$3,736,000	$1,456,000	$2,882,900
		1,905,400		1,832,000		1,456,000
Balance favoring electrification		$1,592,600		$1,904,000		$1,426,900
Percentage of net investment		19.6%		23.7%		20.7%
Net profit, allowing 12% for depreciation, amortization, interest and taxes		7.6%		11.7%		8.7%

But if oil were used, it would cost $700,000 more than the cost of hydro-electric power at 0.75c. per kilowatt-hour, the report states.

The following table gives a summary of the power required and the fuel oil saved by the proposed electrification of the divisions considered in the report:

Division	Kw.-Hr. per Year	Maximum Kw. Demand
Sacramento	104,200,000	47,600
Shasta	73,200,000	33,400
San Joaquin	89,000,000	40,000

The saving of oil in each district, according to the report, would be:

Division	Barrels	Value
Sacramento	978,000	$2,200,000
Shasta	907,300	2,055,000
San Joaquin	1,177,000	1,882,000

The comparative low value of the oil used in the San Joaquin division as shown in the foregoing tabulation is due to the proximity of the district to the largest producing oil fields in California, making it possible to supply steam locomotives with fuel at a much lower rate than in the other two cases considered.

A summary of the first costs, the percentage of profit on the investment and the annual saving obtained in each of the three districts considered in the report is given as follows:

Division	First Cost	Annual Saving	Per Cent
Sacramento	$8,100,000	$1,592,600	7.6
Shasta	8,038,000	1,903,800	11.7
San Joaquin	6,784,000	1,426,900	8.7
Total	$23,012,000	$4,923,300	9.7

In calculating the profit on the investment in the report 12% is allowed for depreciation, amortization, taxes and interest.

No recommendation or suggestion concerning the source of the supply of power is contained in the report. Mr. Folsom stated, however, that should his reccommendation be adopted generating stations would have to be built to meet the demand. The installation of power plants to provide the necessary quantity of power at present costs is estimated at $150 per kilowatt. This would make the cost of generating plants in the neighborhood of $18,500,000 in addition to the cost of electrifying the railroads.

The question of purchase or generation of power for the proposed system is disposed of in the report with the statement that the monthly load factor for industrial uses averages 52% in California, while electric railways seldom exceed 40%. Purchase is therefore recommended, as the larger systems can more readily absorb the railroads' demand for power.

The total first cost for the three divisions is estimated and segregated as follows: Substations, $8,100,000; track bonding, $851,000; transmission line, $3,760,000; contact system, $6,620,000; block signal changes, $1,166,000; inspection shops and sheds, $45,000; electric locomotives, $8,910,000; credit for steam locomotive equipment released, $6,440,000; net total, $23,012,000. By divisions this total is distributed as follows: Sacramento, $8,100,000; Shasta, $8,038,000; San Joaquin, $6,784,000.

The estimate for locomotives includes twenty 150-ton passenger, sixty-three 100-ton freight and ten 100-ton switching locomotives. An allowance of $6,440,000 is made for steam locomotive equipment released by electrification.

The power requirements for the proposed electrification are estimated as follows: 730,000 kw.-hr. per day, 267,400,000 kw.-hr. per year, 121,600 kw. maximum demand and 30,400 kw. average demand.

Estimated comparative operating costs are indicated in the table so labelled.

The report says in part:

Railroads consume more coal and fuel oil than any other single industry. Over 20% of the annual production of coal and fuel oil in the United States is consumed by the railroads, and half this amount is wasted by the inherent inefficiencies of steam locomotives. Western railroads consumed 31.2% of California's 1917 production of fuel oil.

The great saving in locomotive fuel by the generation of power in central power plants is made possible by reason of the fact that the steam locomotive carries its power plant on its back and consumes a large portion of its energy in carrying its own fuel. Roughly, about 12% of the energy of the locomotive fuel supplied to the steam locomotive is used in hauling its own fuel in tenders and in coal cars or oil-tank cars to the distributing points along the line. Other large wastes of fuel are occasioned by the starting of fires, keeping hot and standing at sidings. In mountain districts there is the added waste of keeping up steam on the long downhill grades and more inefficient utilization of fuel on the uphill grades, especially in starting.

Motor Trucks Haul Coal from Mines

At present prices of coal many small mines in Tennessee, along the Cincinnati Southern line of the Southern Ry., are finding it profitable to reopen operations. Several of these mines which have no rail connections are using motor trucks of 1½ to 2 tons capacity for hauling coal to the nearest railway siding, where it may be dumped into a hopper or shoveled into a car.

Oiled Macadam Roads Resurfaced with Concrete

Los Angeles County, California, Builds Roads In Two Sections To Keep Traffic Moving—Center Joint Keeps Autos on Own Side

By E. A. Burt

Assistant Engineer, Los Angeles County, California, Road Department

SEVERAL oiled macadam roads have been resurfaced with concrete in Los Angeles County, California, in the past two years, because they were breaking down under the increased traffic. As it was impossible to close entirely some of these roads, building them in two sections has been tried with excellent results. While this method of construction is slightly more expensive, due to the extra shifting of the equipment and the extra form work required, the advantages to the public are thought at least to counterbalance the extra expense.

CENTER FORM PLACED FOR BUILDING FIRST HALF

An example of this form of construction is the Long Beach Boulevard, the original improvement of which was completed in 1910 and 1911. The construction was typical oiled macadam, 16 ft. wide and 6 in. thick, with 7-ft. oiled earth shoulders. It was laid directly on the adobe or fine silt soil of the region.

The natural slope of the country from Los Angeles to Long Beach averages about 0.2%, and is practically uniorm for a mile or more on either side of the road. Consequently, satisfactory drainage was not obtainable. The general situation of the road left the ground-water level within two or three feet of the surface during the dry months (May to November), with more or less water all over the road and adjoining land during a considerable part of the rainy season.

The suitability of macadam for use under the conditions described was perhaps doubtful, but up to the end of the season of 1913 the surface of the road developed only the defects generally found in new macadam, and it was felt that it would continue to give good service for a reasonable number of years. However, early in 1914, with a traffic shown by census to be 1970 tons per day, it began to give signs of failure, and in 1915 a considerable number of ruts and waves developed. While it was still possible to maintain the road at a rather heavy expense, it was deemed advisable to reconstruct it. However, no funds were available. These unfavorable conditions were further aggravated by the closing of a parallel road, the Harbor Boulevard, on account of floods. The traffic over the road was thus increased to 3200 tons per day, the increase consisting mainly of motor trucks of 3 to 10 tons capacity. Under this sudden and unforeseen traffic, the roadbed being saturated with water from heavy rains, large sections were rapidly pounded into deep ridges, practically destroying 3½ miles of the surface. The previous method of patching with heavy asphaltic oil and rock was now found to be inadequate and entirely too expensive. Finally, in the absence of other funds, it was decided to use for reconstruction money set aside for paved highway maintenance.

After examining several stretches of concrete road which had previously been built in the county, this material was selected for the resurfacing, and in April, 1916, work was begun. The concrete was laid directly on the old macadam surface, no grading being done other than knocking off a few of the high humps and filling up a few of the deeper ruts with loose gravel. Wherever the smooth oiled surface remained it was swept clean with street brooms.

In developing methods of construction it was realized that suspension of traffic on the boulevard was out of the question, it being the only through road to the harbor. Detours along the sides were also impossible, unless a temporary road could be constructed, as the light, silty soil would not support the traffic. Furthermore, highly improved farms bordering the road prevented detours over adjoining land. To solve the problem it was decided to construct one-half of the pavement at a time, the traffic using the old half until the new was finished, and then shifting to the finished half. It was sometimes necessary to build shoulders on the portion being used by traffic, as 12 ft. was not a sufficient width; but as these shoulders had to be constructed eventually, no loss was involved.

HALF SECTION COMPLETED, SIDE ROAD AT RIGHT

Before work was actually started a center-line profile

was run, cross-sections were taken and a grade was established which would bring the finished crown 5 in. above the old surface. The new pavement received a crown of ¼ in. per foot, or a total of ¾ in. for a 24-ft. width. As the old surface had a crown of about 6 in., it is probable that the thickness of the new slab varied from five to nine inches.

In staking out the work 2 x 2-in. hubs were driven to 5 in. below finished grade on the center line of the road. This was found very convenient, as the 2 x 5 in. header boards, used along the center line, could be laid directly on the hubs, thus eliminating all further leveling. This method of setting header boards on the center line, and building one-half the road at a time, has proved so successful that it has been adopted for all work of this character.

Screened river gravel, washed sand and portland cement, mixed in the proportion of 1:2:4, was used for the concrete surfacing. On the first 3½ miles finishing was done with steel and redwood floats. Either type appeared to give good results in riding and wearing surface. All concrete was mixed in an 8-cu.ft. paving mixer. A straight-line crown from the center to the shoulder was used on the work.

ROLLER AND GRADER PUSH MACADAM TO SIDE WHERE GRADE IS TO BE LOWERED

No expansion joints were used on the first 3½ miles, the shrinkage cracks, which occurred about every 25 ft., being filled with heavy asphaltic oil to prevent ravelling. On the parallel half these cracks were much further apart, but so far no explanation has been found for the difference. About one mile of the first work was covered with oil and screenings, making a ¼-in. oil mat. A comparison of this with the remainder seems to indicate that the added expense for oil mat is not warranted.

The longitudinal joint down the center of the road formed by building the pavement in two sections, was also filled with heavy asphaltic oil, and gives the pavement, where it is not covered with oil and screenings, the appearance of being divided into two drives. This feature has been favorably commented on, as it tends to keep motorists on their own side of the road.

On many of the country roads it would be impracticable to lay a 5-in. slab directly on the old paving, as the resulting surface would be too high for the adjoining property. In the case of Long Beach Boulevard, which was 80 ft. wide, it was possible to give the earth shoulders a gradual taper down to the original ground.

MATERIAL AND LABOR COST ON LOS ANGELES COUNTY ROAD

Length 7076.5 ft. (1.34 miles) Average haul 0.6 miles
Width 24 ft. 2593 cu.yd. concrete
Area 169,836 sq.ft. Thickness 5 in.

COST OF LABOR	
Camp expenses	$350 00
Care of traffic	409 85
Preparation of sub-grade	790 19
Unloading sand and gravel from cars	688 30
Hauling sand and gravel from cars	1,212 95
Cement, loading, hauling, storing	378 14
Headers, placing and removing	430 64
Mixing, placing, finishing	1,233 92
Covering, uncovering, watering	671 55
Watchman	221 75
Foreman	416 67
Time-keeper	63 75
Miscellaneous trucking	192 33
General repair and warehouse work	550 11
Surveying, drafting and staking	109 26
Miscellaneous	266 01
Overhead and supervision	762 21
Total	$9,350 03
COST OF MATERIALS	
Gravel, 2,330 tons	$1,796 39
Sand, 2,280 tons	812 56
Cement, 3,807 bbl	6,091 20
Lumber (header boards and stakes)	462 00
Total material	$9,162 15
Total labor	9,350 03
Total	$18,512 18
Cost of labor per cu.yd. concrete	3 61
Cost of material per cu.yd. concrete	3 54
Total cost per cu.yd. concrete	$7 15
Cost of labor per sq.yd. of paving	0 50
Cost of material per sq.yd. of paving	0 48
Total cost per sq.yd. of paving	$0 98
Cost per mile	$13,800

RATES OF WAGES	
Foreman	$5.00 per 8-hr. day
Mixer operator and finishers	3.50 per 8-hr. day
Laborers and teamsters	3.00 per 8-hr. day
Teams	2.50 per 8-hr. day

Recently resurfacing has been carried on under a slightly different plan, the new features being the breaking up and lowering of the old oiled macadam, the use of a roller and belt for finishing the concrete, and the placing of expansion joints at the end of each half-day's run, or about every 325 feet.

Laying the concrete directly on the old pavement was abandoned for two principal reasons: First, it was necessary to lower the grade in many places in order to conform with curbs already built; second, it was found by trial that the extra expense of grading was more than offset by the saving in concrete. The plan in use at present is to root up the macadam with a steam roller and rooter, spread out the material to the proper width and grade, remove any excess, set the header boards and bring the macadam sub-base to the proper grade by rolling. In some cases it has been necessary to push the entire rock surface to the side with a grader, remove the excess soil and push the rock back into proper position. The grader being used with a steam roller is shown in an illustration.

The table gives the quantity and cost of the work on one of the more recent jobs, but of course these prices are only comparative when costs of material and labor are changing so rapidly.

The work described was carried on under the general supervision of F. H. Joyner, road commissioner of Los Angeles County, and under the direct supervision of Walter Moore, Jr., district engineer, the writer being assistant engineer.

Some Experiences With Large-Capacity Reservoir Outlets

Specially Designed Gates Control Discharge of Immense Volumes of Water Under Pressures Above 200 Feet—Difficulties and How They Have Been Overcome

By James M. Gaylord
Electrical Engineer, United States Reclamation Service, Denver, Colo.

This paper, the substance of which was presented informally some months ago before the Colorado Association of Members of the American Society of Civil Engineers, admirably supplements D. W. Cole's review of the development of high-pressure gates in waterworks and irrigation reservoirs, published in Engineering News-Record of last week, page 880.—Editor.

When the United States Reclamation Service began the construction of its first large dams, there were no well established precedents which could be followed in the design of the large-capacity outlet works required, and it was therefore necessary to do much development work before this problem was solved. The data obtained during the course of the earlier developments were applied to later designs and led to some very successful installations. It is the purpose of this paper to describe some of the phenomena observed and the methods used in overcoming the early difficulties. One of the most successful later installations is also described.

It is not a very difficult matter to discharge a few second-feet of water under a head of one or two hundred feet, nor does the releasing of thousands of second-feet cause the designer much anxiety where the head is less than, say, 50 ft., but when thousands of second-feet must be released under any head from empty reservoir to two or three hundred feet, and when the flow must be regulated to a nicety at all times, the problem becomes one which must be approached with due respect, as the results of many installations eloquently testify.

Enormous Amount of Power Involved

The source of the difficulty is mainly the enormous amount of power involved in the discharge. In some cases, this reaches hundreds of thousands of horsepower, millions of foot-pounds per second. If the discharge can be passed through waterwheels, a large portion of the energy can be put to useful service, but the problem at a storage dam usually is to find a means of throwing this power away without damaging the structure. With high heads, the velocities of the flowing water become very great, and it appears that the troubles, like many other hydraulic functions, increase as a high power of the velocity.

The close regulation of discharge to meet the varying demands of irrigation adds difficulty to the problem; it requires that a movable part of the valve must be continually in contact with the highest velocity of the water since it is at this point that regulation must be effected. Silt also contributes its share of difficulties, for not only does it erode metal surfaces by sand-blast action, but in many cases it deposits a scale which fills up close clearance spaces and causes sticking of the valve.

The experience of the United States Reclamation Service in the construction of large reservoir outlets clearly establishes the fact that the design of the outlet channel, pipe or tunnel is of no less importance than the proper design of the regulating devices themselves. In fact, the valves have, as a rule, withstood the service better than the other parts of the outlet works.

Roosevelt Dam Gates Under 226-Foot Head

One of the first high head-gate problems was at the Roosevelt Dam, where regulation of the discharge up to a maximum of 3000 sec.-ft. is required, and where the head reached a maximum of 226 ft., measured from the crest of the spillway to the stream bed. In the construction of this dam, the stream was diverted through a sluicing tunnel, 12 ft. wide, 10 ft. high and 490 ft. long, driven through solid rock at the south end of the dam about river-bed elevation. This tunnel was to be closed by gates of special design, and it was attempted to make these gates adequate in strength and capacity to regulate the outflow from the reservoir. The installation includes two sets of three gates each, the downstream set for regulation and the upstream set for emergency closure to inspect or repair the regulating gates. Each gate closes an opening 10 x 5 ft. and is operated by a hydraulic cylinder located in a well extending down from the top of the dam to a point 33 ft. above the flow of the sluicing tunnel. The installation was fully described in *Engineering News* of May 30, 1907, p. 589. The gate and frame is provided with battered bronze facing strips. The batter of the stationary face corresponds to that of the movable strip, and, when the gate is closed, these faces come into contact. As soon as the gate is raised slightly the load is transferred to roller trains operating between the stationary and the movable track. Under maximum head (226 ft.), the total water load on each gate leaf amounts to 800,000 lb. and on each 4-in. roller the load is 13,000 pounds.

Outlet Works Damaged

Water was turned through the gates for the first time in June, 1908. All the gates were opened wide and allowed to discharge freely for several months, during which time the head reached a maximum of 90 ft. In the following May an examination was made of the tunnel and gates, and damage to the outlet works was discovered. All the roller trains were broken or gone. Some of the deflection plates belonging to the walls above the gates had been carried away or loosened. The bronze gate seats were all damaged by blows from loose parts. Practically all of the nuts and bolts had been loosened, apparently by the vibration, and even the large nuts fastening the leaves to the piston rods were turned, one being 4 in. out of place. The concrete in the roof, floor and piers was badly damaged; a piece about 10 ft. in diameter had fallen from the

roof about 20 ft. below the gates. The concrete floor, extending 20 ft. below, had been undercut several feet back toward the piers.

Temporary repairs were made, and in an attempt to supply an urgent demand for water the gates were operated for two days. At the end of this time it was found that the entire concrete floor and much of the concrete in the piers had been washed out and in one case a passage made under the sill of a gate.

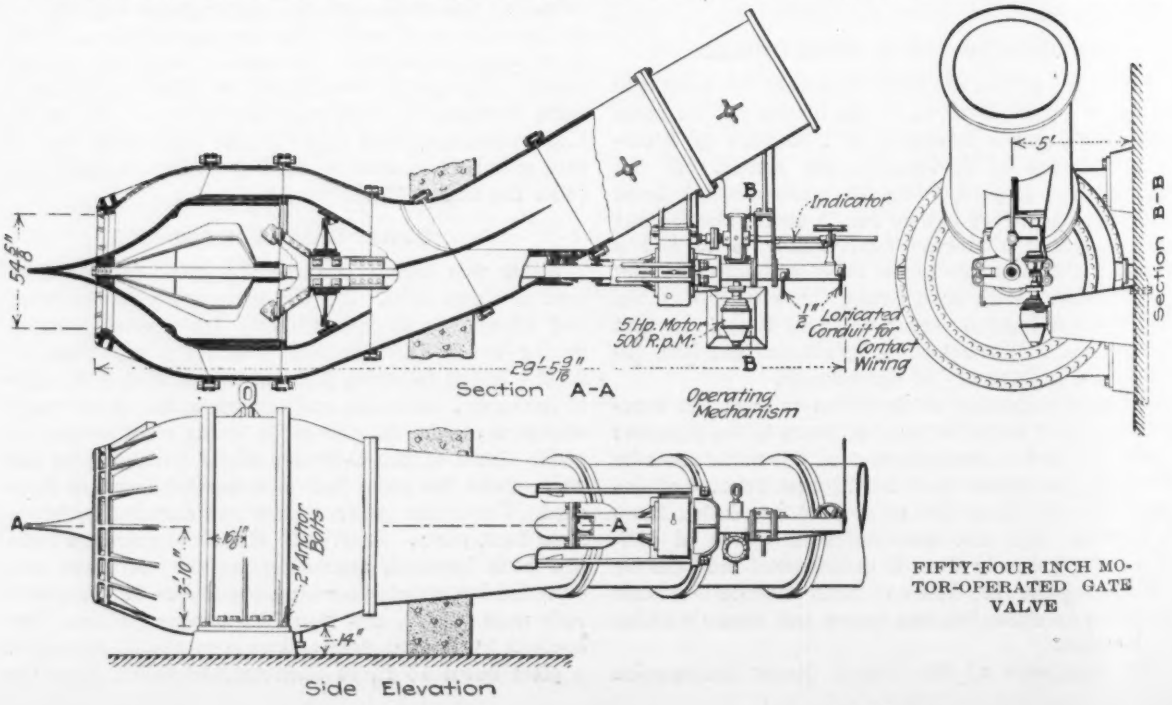
Ensign Balanced Valves

These results, together with unsatisfactory reports from the operation of sliding gates elsewhere, indicated the advisability of attacking the problem from a different angle. It was apparent that the damage had resulted not only from the scouring action of the high-velocity discharge but also from violent disturbance caused by the obstruction which the gate leaf, in partially opened position, offers to the flow of water. The nature of these disturbances received further study, and certain relief measures were taken in connection with the sliding gates at the Pathfinder Dam which will be described later. At the Roosevelt Dam, however, regulation by means of the sliding gates was abandoned, and new designs were prepared in which the central idea was to produce an efficient device; that is to say, one which would destroy the least possible amount of the energy, thereby protecting itself from violent disturbances and destructive forces which the sliding gate had experienced. The new devices have given remarkably good service and are still in operation. Their efficiency, however, has proved something of a disadvantage, since it has transferred the damage from the regulating devices to the outflow conduit. A new class of difficulties has also arisen with the valves, but these are mainly in the details of construction and not of a fundamental nature.

The new valves are known as the Ensign balanced valves. They have been made in several different designs, the most successful of which is the type for mounting on the face of the dam, completely submerged in the reservoir. Three valves of this type are installed at the Roosevelt Dam. The device consists essentially of a cylindrical piston with one end pointed to guide and regulate the discharge. The other end is provided with a bull ring of larger diameter, fitting a stationary cylinder in which it moves. The cylinder is attached to the circular base casting by a supporting grillage through which the water flows in a radial direction. Striking the pointed end of the plug, the flow is turned through an angle of 90° and discharged axially through the base casting into the circular outlet pipe.

Easy Control Feature of Balanced Valve

One of the principal advantages of this type of valve is the ease with which it can be controlled. While a sliding gate requires for its operation external power to overcome very heavy forces due to frictional resistance and weight of moving parts, the balanced valve is operated by means of the pressure of the water in which it is submerged, by simply balancing or unbalancing the pressures acting on the movable piston. The bull ring fits the cylinder with a clearance of 0.005 in. on the diameter. Through this clearance, the pressures inside and outside of the cylinder will be equalized, provided the outlet from the cylinder is closed. Given equal pressures inside and outside of the cylinder, the valve piston will be held against its seat like a check valve, since the pointed end is in this position subjected to atmospheric pressure only—the pressure in the empty discharge conduit. The pressure in the cylinder can be reduced by opening a drain larger than the clearance space around the bull ring, and can be reduced below atmosphere by applying a vacuum. With the pressure in the cylinder reduced to atmosphere, the atmospheric pressure on



FIFTY-FOUR INCH MOTOR-OPERATED GATE VALVE

the pointed end of the piston will be balanced by the equal pressure on a corresponding area inside the cylinder. The annular space between the circumference of the plug and the circumference of the bull ring will be subjected to reservoir pressure tending to move the plug from its seat, and the corresponding area in the cylinder has only atmospheric pressure. The resultant is a net opening force on the piston which will slowly move it from its closed position.

Valve Closed by Unbalanced Pressure

If it is desired to close the valve, the outlet from the cylinder is closed, and as the pressure accumulates in the cylinder through the clearance space the valve is unbalanced in the opposite direction, since the pressure in the cylinder is the same as that on the annular ring and the pressure on the pointed end is less than reservoir pressure on account of the velocity of the water. The reaction of the jet also enters into this calculation as an opening force, but the net result is a force tending to close the valve.

For regulating service, some means of establishing equilibrium at the desired gate opening must be provided. At Roosevelt, this was attempted by means of a resistance tube arranged to increase the frictional resistance to outflow of water from the cylinder as the valve opens. The increase of friction tends to build up the pressure behind the piston and check its further movement. The resistance tube consists of a stationary tube connected with the control pipe and extending through the head into the main cylinder. The outer surface of this tube is grooved, and it closely fits a corresponding bored recess in the main piston. The control water must pass through the clearance between the tube and the recess, and the resistance at this point increases as the valve opens and forces the tube farther and farther into the bore. This increase of resistance increases the pressure in the cylinder and tends to reëstablish equilibrium of the forces acting on the piston.

Needle Valves Used to Adjust Control Valves

The use of this device requires careful adjustment of the control valve, and for this purpose needle valves are used. For each setting of the control valve the main valve will stop at that point in its stroke where the forces acting on the piston find equilibrium by adjustment of the hydraulic pressure gradient through the several resistances at bull ring, resistance tube and control valve.

The balanced valves at Roosevelt have given good service. They have been operated under heads up to 110 ft. during seven years and are still in serviceable condition. Certain phenomena have, however, been observed in this installation which have been of much assistance in studying the valve problem and which have necessitated further changes in the outlet works. The resistance tube control has proved unreliable as a means of close regulation, owing to the fact that the point of equilibrium is not well defined and a slight accumulation of sediment at any one of the resistance points will disturb the balance and cause a movement of the piston.

The setting of the valve for a certain desired discharge requires much patience and, after being set, the valves will sometimes change position without apparent cause. Another unexpected difficulty has been the chemical action of the water on the cast iron of the cylinder. The reservoir water contains salt in considerable quantities as well as gases in solution. These chemicals have caused the scaling of the inner surfaces of the cylinder, and the scale thus formed is gradually wearing the cylinder lining and piston and increasing the leakage clearance around the bull ring, making it difficult to open the valves. As they are submerged in the reservoir and therefore inaccessible except at low water, repairs cannot be made when required.

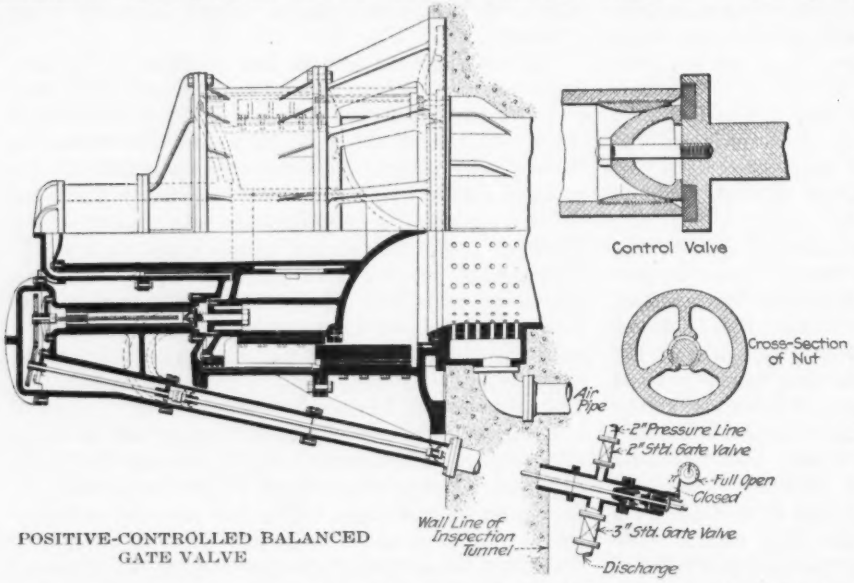
The most serious damage has occurred in the conduits below the valves. These conduits are lined with cast-iron bell-and-spigot pipe 5 ft. in internal diameter for a distance of about 80 ft. to a point where the three pipes converge into the outlet tunnel. At the point of convergence some erosion has taken place, but it has been possible to patch this with concrete. Immediately below the valves the cast-iron pipes began to show serious wear and cavitation after two or three seasons of operation. This action, which is attributed to the formation of a vacuum at this point, continued until the pitting extended entirely through the metal and for some distance into the surrounding concrete. This phenomenon has received much thought, and two cures have been very effectually carried out at other installations. The damage being apparently due to the effect of vacuum, means were sought to prevent the formation of a vacuum. This has been accomplished by the admission of air to this point of the jet and by installing throat pieces to approximate the shape of the contracted vein. Neither of these methods appeared wholly practicable at Roosevelt, and it has been decided to install within the outlet tubes steel linings connected to the valves by bronze throat pieces and to extend these pipes through the tunnel to the face of the cliff where motor-operated needle valves are to be installed. The steel linings are fitted with outside butt-strap joints for both circumferential and round seams, and countersunk rivets and patch bolts are used so that the finished pipe will be perfectly smooth on the inside. The space between the steel lining and the cast-iron pipe is to be filled with grout through holes provided for the purpose in the steel lining. Beyond the cast-iron pipes it is planned to continue the outlets as reinforced-concrete pipes connecting with the valves at the face of the cliff.

Motor-Driven Screw and Nut

The new valves are of the needle type and are operated by means of a screw and nut driven by a motor. This valve was designed to meet the following requirements: (1) A positive self-locking operating mechanism; (2) no close fits under water except at narrow guides; (3) free access of air to the jet; (4) absorption of energy at a point safely below the works, and (5) a valve accessible for inspection and repairs.

The valve has a free opening equivalent to 54 in. in diameter and is designed to produce a clear solid jet with maximum efficiency. The needle is provided with four bronze shoes and slides in a bronze-lined

cylinder supported in the center of the water passage by means of radial ribs. The upstream end of this inner, stationary cylinder terminates in a conical casting which serves to prevent impact of the incoming water against the rear end of the needle. The shaft extends through a stuffing-box and is threaded for a bronze nut which operates between heavy roller-thrust bearings. The nut is driven by a motor and worm gear, all gearing being submerged in oil. The end of the shaft is squared to prevent rotation, and is provided with an indicator and limit switch contacts. A certain amount of water pressure can be removed from the needle by venting the space behind the needle, and for this purpose 6-in. motor-operated valves are to be installed. These valve motors as well as the main needle valve operating motors are to be controlled from the power house across the river by means of electrically operated remote control contactors. The operating motors are designed for limited stalling torque to protect the mechanism against excessive strain, and limit switches and overload circuit breakers are provided as additional protection.



POSITIVE-CONTROLLED BALANCED GATE VALVE

These valves will probably be installed during the winter of 1918-19, and it is hoped that the final solution of this problem has now been found.

At the Pathfinder Dam in Wyoming sliding gates were installed when the dam was built. The installation is, in many respects, similar to that of the Roosevelt Dam but the gates were of a different type, being sliding gates of very massive construction and special design.

As was the case at Roosevelt, it was the intention to install two sets of gates, but only the upper or emergency set of four gates was ever put in.

The Pathfinder gates have clear openings 3 ft. 8 in. x 6 ft. 2 in., and are operated by hydraulic cylinders 24 in. in diameter. The gate leaves are of massive construction, the frames are very heavy and the piers were lined with heavy boiler plate. The head above the gate sills attains a maximum of 180 ft. with full reservoir, and the discharge has been regulated by means of these gates up to this maximum.

The installation of the gates was completed in April, 1908, and during the summer of that year they were operated wide open. During the season of 1909 the gates were operated at full and partial discharge up to heads of 175 ft. In June, it was discovered that water was backing up in the gate chamber through a 2-in. pipe connecting with the tunnel below the gates, indicating that the tunnel was operating under pressure at this point and that something had gone wrong. The reservoir was emptied in the fall of 1909 and the tunnel carefully inspected. The floor of the tunnel was found to be torn up for a distance of 130 ft. below the gates, the steel plate linings were about one-third gone and a portion of the concrete lining was destroyed. A large slab of rock had rolled into the tunnel, partially blocking it and causing the pressure indications above noted. In marked contrast with these conditions, a straight concrete-lined conduit through the dam, discharging continuously and without obstruction or valve under heads up to 140 ft., showed no sign of wear. Two straight cast-iron pipes 3 ft. in diameter had also been discharging freely under heads up to 158 ft. and showed no damage. The boiler-plate linings were replaced by heavy iron castings anchored into the concrete and provided with weep holes to relieve internal pressure, but during the season of 1911 these castings fared no better than the steel plates in 1909, and it was found that the floor of the tunnel again suffered damage from the heavy discharge.

A careful study was made of the various phenomena, and it was concluded that the major part, if not all, of the trouble with the gates and outlet chambers could be attributed to vacuum effects of the jet and the resulting vibrations and disturbances. This conclusion was supported by the observation that a discharge through the gates of sufficient volume to cause the sealing of the tunnel below these gate chambers, and the consequent exclusion of air therefrom, would at the same time cause an increasing series of disturbances in the tunnel below these outlet chambers, ranging from tremendous periodic surging of air with an accompanying booming noise resembling distant thunder, to explosive gusts accompanied with peals and detonations of great violence, apparently in proportion to the volume of water discharged and the degree of air exclusion effected.

The cure for the greater part of these troubles was very simple and effective. The tunnel was repaired, air was admitted through the lower gate shaft mentioned above, and the discharge limited to an amount which does not seal the tunnel outlet. This has effectually eliminated the vacuum below the gates and the

gates have been operated to date, as occasion demanded, without material damage. As regulating devices under heads above 60 or 80 ft., the use of a sliding gate is not recommended, and the operation of these gates for nine years under heads up to 180 ft. is cited as a remarkably good showing.

Balanced Valves Displace Sliding Gates

The sliding gates, as a means of regulating the outflow from the Pathfinder reservoir, have been superseded by six balanced valves installed in the south tunnel in the spring of 1912. These valves are duplicates of those installed at Roosevelt and discharge through cast-iron pipes and flaring castings into a tunnel 13 ft. wide by 14 ft. high, driven 360 ft. through solid rock around the south end of the dam. The valves are mounted on the face of a concrete plug at the upper end of the tunnel and are protected by a grillage. The control pipes were embedded in concrete in the floor of the outlet tunnel, the lower ends of the pipes being brought out to a control house on the face of the cliff below the dam.

At the time of the installation of these valves the agencies which caused the destruction below the sliding gates were not understood. No provision was made for the free admission of air below these gate chambers, with the result that the concrete floor below the discharge tubing was destroyed mostly after a sufficient volume of water to exclude free access of air was discharged, and with the destruction of this floor the control pipes became exposed and opened, making the further control of these valves impossible for the season. By this time the cause of the difficulty had been discovered, and a remedy was promptly applied by admitting air to the tunnel just below the discharge tube and locating the control pipes in an auxiliary tunnel which also serves to admit the necessary supply of air. The trouble with the 5-ft. discharge pipes, however, continued until the pipes were worn through and the concrete showed serious damage. This wear was undoubtedly due partly to cavitation, partly to attrition and partly to poor material in the linings. The tubes have been lined with riveted-steel pipes, 4 in. smaller in diameter, grouted into the tubing and attached to the balanced valves by bronze throat pieces. These linings have withstood four years' service with practically no damage beyond a slight pitting of the throat pieces. The balanced valves themselves have shown no signs of wear.

Variable Head at Arrowrock Dam

When the design of the outlet works of the Arrowrock Dam in Idaho was undertaken, the experiences at the Roosevelt and Pathfinder Dams were available precedents, and the successful operation of the Arrowrock high-pressure valves is proof that progress has been made toward the solution of this difficult problem.

The head at this dam varies from 60 to 230 ft. and the regulated flow reaches a maximum of about 9000 sec.-ft. The dam is of the concrete gravity type, arched upstream on a radius of 660 ft. The main outlets consist of 20 straight tubes 52 in. in diameter extending on radial lines through the dam, the jets being allowed to fall freely into a pool below the toe. The tubes are arranged in two horizontal tiers, 66 ft. and 153 ft., respectively, above stream bed, and each tube is controlled by a 58-in. Ensign balanced valve. Of each set of 10 valves, three are provided with special sleeve controls and are used as regulating valves, while the remaining seven are provided with plain controls and are used only for full open discharge. The lower valves are provided with trash racks while the upper valves have none. The recorded history of the Boise River, studied in connection with the irrigation demands, makes it almost certain that the reservoir will be practically emptied every year, so that the valves will be accessible for frequent inspection and repairs, if necessary. This fact, together with the absence of silt, makes the Arrowrock Dam especially favorable for the installation of this type of valve.

Sleeve Control for Regulating Valves

In general design, the valves are almost identical with those at Pathfinder and Roosevelt, but in the method of control of the regulating valves there is a radical difference. In the sleeve-controlled valve, the control pipe connects at the cylinder head with a movable sleeve extending into the main cylinder and operated from a chamber inside the dam by means of shafting and gears. On the main piston, opposite the movable sleeve, is an acorn-shaped seat which, when in contact with the inner end of the sleeve, cuts off all outflow from the cylinder. The control shaft is carried inside of the control pipe to the chamber in the dam where it passes through a stuffing-box and terminates in a crank and indicator.

When it is desired to open the valve the sleeve is withdrawn from its seat, which relieves the pressure in the cylinder and allows an opening movement of the piston. This motion continues until the seat approaches the movable sleeve, partially closing the outlet and building up the pressure in the cylinder until the movement of the piston is checked. To close the valve, the control crank is rotated fast enough to keep the sleeve in contact with its seat and the outlet through the control pipe entirely closed while the piston is forced to its seat by the pressure accumulating in the cylinder.

Air Supply Provided

The six sleeve-control valves, all of which are operated at partial opening for regulation, are provided with throat pieces of semi-steel just below the valve and air is supplied at this point through a large number of small holes extending half way around the pipe. The air-inlet castings connect with pipes extending to the top of the dam. The outlet tubes are perfectly straight and extend radially through the dam. They are lined with semi-steel pipes for a distance of about 27 ft., the remainder of the pipe being unlined. Great care was taken to make these pipes perfectly smooth, and they are painted with water-gas and coal tar throughout their entire length.

The operation of the valves for three seasons under heads as high as 130 ft. has been perfectly satisfactory. The control of the discharge is absolute, and no damage has occurred either to the valves or to the outlets. This excellent record is attributed largely to the efficiency of the outlets, which permits the greater part of the energy

of discharge to be passed on and absorbed in the pool below the dam. The perfectly straight alignment of the tubes and the admission of air at the throat of the regulating valves have materially improved the efficiency and have made the satisfactory operation possible.

In addition to the regulating outlets, there are 5 x 5-ft. sluice gates in straight radial passages through the dam, 15 ft. above stream-bed elevation. These gates are operated by hydraulic cylinders in an inspection gallery in the dam and are arranged so that with empty reservoir the leaves can be hoisted into this gallery, if necessary, for repairs. The sluice gates are not designed for regulating service, but are intended for wide open discharge only under heads of less than 70 ft. They can be opened, if necessary, under heads of 125 ft. or more. This design provides for the admission of air at the top of the gate just below the leaf, in order to prevent the formation of a vacuum, with its resultant disturbances, while the gate is being opened. The operation of these gates has been equally as satisfactory as the balanced valves, and if the entire outlet works were to be redesigned today few, if any, changes would be made.

One Set of Wood Forms Used Three Times Completes Concrete Foundry

Form Units Assembled on Ground With Reinforcement In Place Erected by Derrick—Telescoping Chute Placed Concrete

By J. M. Villadsen
Salt Lake City, Utah

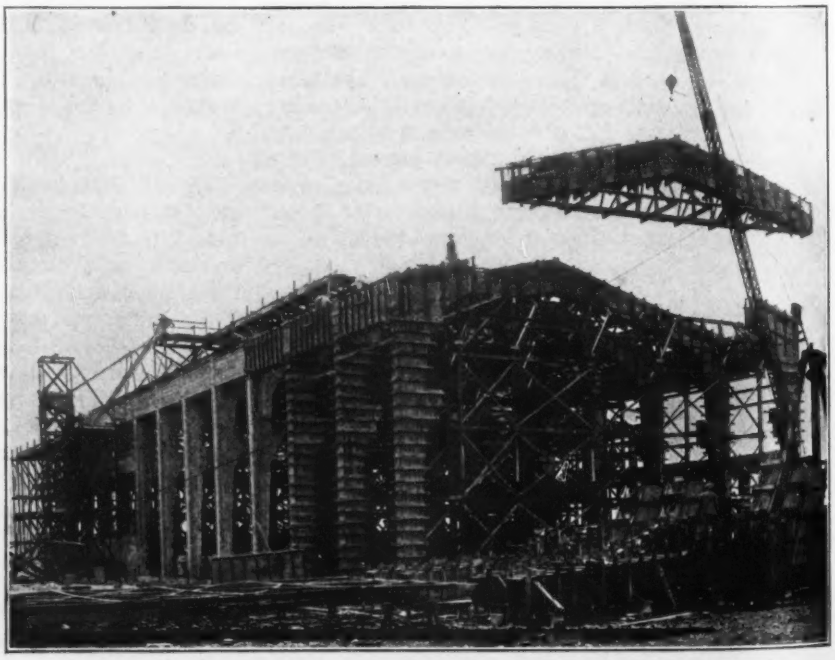
TWO-HINGED arch bents concreted in two lifts form the supporting frame of a new foundry building recently completed for the Garfield Smelting Co. This type of construction, besides permitting attractive architectural treatment and giving ample light and an unobstructed interior, as shown by the views, greatly simplified concreting operations. All concrete was chuted directly into the forms. They were assembled and erected in a few large units with reinforcement in place, and one set of forms was used three times for the whole building.

Arch-bent concreting was the governing condition. There were 14 of these bents, each with a span of 70 ft. and a height of 44 ft. Forms were constructed for the first four bents; reused, with an additional form, for the middle five bents, and again reused for the remaining bents. This reuse of forms is a very important factor in the low cost of construction of the type of structure illustrated. On account of the unusually heavy form sections and the great ceiling height, it was necessary to plan the exact sequence of all erection operations very carefully. To help visualize the exact working conditions a form model, representing the first two bents of the building with all scaffolding and supports, was built on a scale of ½ in. to 1 ft. The erection derrick, represented on the same scale, was used to manipulate the form units. From these studies piling diagrams were laid out, locating the position of every piece on the ground. An interesting item in the form construction is the use of double-head nails for joints which must come apart again on stripping. On these nails, the second head is placed about ¼ in. below the first. The nail may be driven home but still leave a head projecting to be pulled, thus effecting a considerable saving in lumber and labor.

The forms were cut in the construction saw mill and partly assembled on a large platform at the mill site into sides, ends and bottoms, leaving the final assembly into complete form units to be done under a 6-ton traveling stiff-leg derrick with a 70-ft. boom, a 30-hp. boiler and a single-drum hoist. The principal use of the derrick was to hoist the completed form units into place, as shown by the illustration. Reinforcing rods were all in place in the forms before they were raised. This method of form erection necessitates form designs as perfectly worked out as if they represented steel structures.

Concrete was distributed by carts running on scaffolding above the roof. Telescoping sheet-iron spouts were provided to chute the concrete down the long columns; these telescoped as the concrete rose in the forms. Traps or openings were left in the sides of the column forms, for tamping.

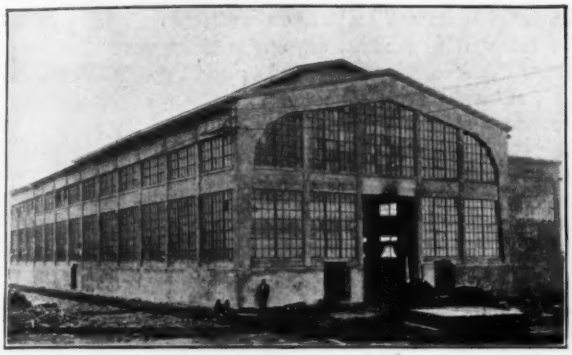
A section of form bents was concreted in two suc-



DERRICK ERECTED FORM UNITS WITH REINFORCEMENT IN PLACE

cessive working days, the first day being devoted to the legs from the foundation up to the haunches, about 29 ft., and the second day to concreting the arch beams. An interesting deviation from this schedule was necessary on one occasion when a breakdown of the mixer made it impossible to carry out the plan of concreting two of the legs in the second section of the building. On the following day the concreting of the whole section was completed; this required the pouring of one bent from foundation to ridge, a height of 45 ft., in nine hours. The forms were carefully watched to make sure that they would not burst under the heavy pressure, but no signs of weakness developed.

The rate of erection was 11 working days per section, a section, as previously explained, being about one-third of the building. In other words, it took 11 working days to strip the form in section 1, repair it, reerect in section 2 and fill it with concrete again. It was found very beneficial, in getting smooth casting, to add hydrated lime in the proportion of about 5% of the cement, to make the material flow more freely.



TWO-HINGE ARCH-BENT FRAME PERMITS LARGE WINDOWS AND UNOBSTRUCTED INTERIOR

Upon the decision of the Garfield Smelting Co. to erect a foundry building, Villadsen Brothers, Inc., were asked to submit a design and proposal in reinforced concrete, in competition with structural steel. The advantages of the low first cost, fire-resisting quality, speed of delivery, large window area, and negligible maintenance expense, were so marked in favor of the concrete design that it was accepted, and the contract was awarded to its designers, on the recommendation of F. M. Martin, chief mechanical engineer of the American Smelting & Refining Co., and C. F. Buck, chief engineer of the Garfield Smelting Company.

The unusual feature of the design is the rigid-frame concrete construction over the main foundry floor. This frame is designed as a two-hinged arch provided with brackets for crane beams at a height of 24 ft. above the floor. A 20-ton traveling crane of 60-ft. span is carried on the brackets.

The concrete frame with long, high spans, as shown in these illustrations, is a type of structure which has probably come to stay. Its development might have been delayed longer if the price of steel had remained normal, but the high price of steel, especially in the structural and plate forms, accompanied by a feeling that it has been unpatriotic to use up much of it, has therefore made the extension of concrete construction logical.

Special Paints for Concrete Ships

OUTSIDE coatings of protective paint for all the Government's concrete ships, and varnish coats for the inside of the oil tankers, have been developed by the concrete ship department of the Emergency Fleet Corporation.

Rudolph J. Wig, head of the department, describes them as follows in a paper presented before the Society of Naval Architects and Marine Engineers Nov. 14:

A priming coat of magnesium fluosilicate ($MgSiFl_6$) is applied to the entire hull. The solution shall contain not less than 15 per cent. by weight of salt and not more than one per cent. of any other substance in solution nor more than 0.2 per cent. of total chlorine. The paint which will give the best service has not been determined upon.

Two types of paint are being tried. One of them is a high-grade spar varnish which is applied in two coats, and the other a bituminous paint consisting of asphalt base thinned with petroleum distillate. One or two coats of this latter are applied, followed by a coat of the same paint thickened with about 15 per cent. of finely powdered siliceous matter and 15 per cent. short-fibered mineral asbestos. An antifouling paint is applied on under-water parts and a boat topping paint on the upper portion. While the concrete does not require any special treatment in order to make it impervious to water or ordinary crude oils, it will not hold the lighter oils unless the concrete is of exceptional quality. As a further guarantee of imperviousness, it is proposed to apply to the concrete a coating of spar varnish which will make it impervious to all mineral oils.

Seattle Makes Record in Sale of Municipal Bonds

A record in the rapid selling of municipal bonds was recently made by the City of Seattle in disposing of $1,500,000 worth of 5% bonds for $1,383,900 in less than three hours from the time they were placed on the market. The bonds, known as "Skagit Utility," were authorized by the Capital Issues Committee of the War Finance Corporation for the development of the Skagit water-power project, as mentioned in *Engineering News-Record* of Aug. 15, p. 336, the requirements of the City of Seattle for additional power having been outlined in *Engineering News-Record* of Aug. 1, p. 248.

ENGINEERING LITERATURE

A REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

The City as an Ally of Business

AMERICAN CITIES: THEIR METHODS OF BUSINESS—By Arthur Benson Gilbert, M.A., Formerly with the Extension Division, State University of Iowa. New York: The MacMillan Co. Cloth; 5 x 8 in.; pp. 234. $1.50.

Making the city help its local business interests so that they have a "differential" over business in other cities, and so that the city as a whole will lead others, is the unusual theme of this book.

After an introductory chapter, the author considers external costs, the proper object for city promotion, costs of material and labor, land, capital, public ownership of utilities, city government and the manager plan, and the industrial survey—all in relation to the main theme. A closing chapter, entitled "The Force of Circumstances," deals with various conditions which, in the author's opinion, inhibit city and business growth.

The author deprecates acquisition of wealth through mere ownership, in so far as it places a burden on production. He favors municipal ownership, taxation of land rather than improvements, liberal treatment of labor, and the newer schemes of city government, including both the commission-manager plan and proportional representation.

The book deserves thoughtful attention, with allowances for the one-sideness common to propagandists, and with patience for lack of clearness at points. The author ignores the fact that his production "differentials" in favor of a given city would disappear if all cities were to adopt with full success the various measures which he advocates. True, there is no immediate danger that this will occur, but some attention might well have been given to making the most of natural local advantages.

Railway Track for Mines

MINE TRACKS, THEIR LOCATION AND CONSTRUCTION: Treating Briefly on the Materials Used and the Principles Involved in the Design and Installation, With a Set of Rules for a Standard Practice—By J. McCrystle, E. M. New York: McGraw-Hill Co., Inc., London: Hill Publishing Co., Ltd. Leather, 5 x 8 in.; pp. 105; Illustrated. $1.50.

That improvement in mine haulage and equipment should lead to greater consideration of track layout and material in the interest of economical operation is the viewpoint of the author. The book is somewhat of a pioneer in a special line, therefore, and its subjects are treated both analytically and descriptively. It deals particularly with the main underground lines, and to some extent with the surface tracks, but as much track work in mines is necessarily of a rough-and-ready character some notes on improvised or special methods and devices might have been included. Omission of reference to portable tracks is rather surprising, and more information as to steel ties and their fastenings would have been appropriate.

Of particular interest are the rules for track work and maintenance, since such work in mines left usually to the personal ideas of the foremen. The rules follow the general line of those used in regular railway track work, but are modified to meet the special conditions. Nothing is said, however as to the organization of the track forces. Typographically, the book is good, but the comparisons of rails on p. 3 might have been expressed more clearly in tabular form.

Economics of the Motor Truck

THE MOTOR TRUCK AS AN AID TO BUSINESS PROFITS—By S. V. Norton. Chicago, Ill.: A. W. Shaw Co. Cloth; 7 x 10 in.; pp. 498; illustrated. $7.50.

As the title of his book implies, Mr. Norton has undertaken to set forth the conditions and methods to be followed in making the motor truck pay. To quote from the coverlet, "What will it do in dollars and cents is a natural question," and this is the question the book proposes to answer. The first book of its kind published, so far as we know, it contains a mass of information on its subject; so much, in fact, that it might be considered a handbook for the industry.

The book is written primarily for the motor-truck operator, and the author treats the question on a plane requiring no extensive technical or mathematical knowledge. For this reason the explanations and illustrations will seem elementary to the engineer or the automobile designer, but will be appreciated by the nontechnical business man who wishes to learn how to get the most out of his trucks. In style it reads like a story and is free from that dryness which characterizes most reference handbooks.

The subject matter is treated under five main heads. The author states that the information and plans suggested have been collected from those who have actually tried them out and found them to work. It is therefore not an expression of the individual idea of any one authority, but of hundreds.

Part I covers the general subject, "Fitting the Motor Truck Into Your Business," and includes such topics as "The Field of the Motor Truck in Modern Business"; "When to Change from Horse to Motor Delivery"; "Cost Keeping," and "Selecting the Right Trucks for Your Work." Part II treats of "Making Your Motor Truck Do More and Better Work," under chapter heads such as "Planning the Delivery System"; "Effective Scheduling and Routing"; "Principles Governing the Use of Trailers," and "How to Get Your Drivers' Cooperation." Part III deals with the subject of "Maintenance that Lowers the Cost of Upkeep," and covers topics such as lubrication, tires, overloading, and garage problems. Part IV describes various methods of "Building New Business with Your Motor Truck," and Part V takes up "Present Tasks and Future Problems," dealing with coöperation, legislation, etc.

The book is instructively illustrated both by half tones and drawings. Treating as it does practically every phase of the economic operation of trucks and trailers, it is well worth owning by those interested both for reading and as a book of reference.

A Monumental Discussion

A STUDY OF ENGINEERING EDUCATION: Prepared for the Joint Committee on Engineering Education of the National Engineering Societies—By Charles Riborg Mann. The Carnegie Foundation for the Advancement of Teaching. New York: The Carnegie Foundation. Paper, 7 x 10 in.; pp. 130. Copies furnished upon request.

This report is the culmination of an investigation instituted in 1907 by the Society for the Promotion of Engineering Education. The national engineering societies joined with that society in the appointment of a committee to study the problem of engineering education, and subsequently the Carnegie Foundation was induced to take up the investigation on a large scale. Dr. Mann was retained to give his entire time to it, and this report follows three years devoted to the study.

Dr. Mann finds much to criticise in present-day engineering education. His theory is that the primary purpose of engineering is to increase intelligent production. On that basis he finds present-day curricula, while adequate as to the technical side, badly deficient in teaching judgment, understanding of men, appreciation of the relation of values and costs. Among the changes proposed by Dr. Mann are closer coöperation and better coördination of the prospective engineer's needs among the several departments of instruction; the introduction of practical experience with engineering materials into the freshman year, and more emphasis on humanistic studies. He also advocates a better system of testing and grading students, not only at entrance, but during their entire course of study.

A lengthy abstract of the report was printed in *Engineering News-Record* of Oct. 24, p. 742. The report is probably the most comprehensive discussion of the subject ever published, and deserves the widest distribution and most careful study.

Engineering Societies Offer Library Service

Engineers outside of New York City are served by the Engineering Societies' library in several ways, according to statements made by Alfred D. Flinn, secretary of the Engineering Council, during a trip through the West. Letters from outside engineers are turned over to a special assistant, who searches for the answer to questions and compiles a list of references to books and articles which seem pertinent. This is mailed to the inquirer. In many cases much of this material is available in local libraries. Whenever it is not, the Engineering Societies Library will make copies of any or all of the references, will translate those in foreign tongues, and will, in fact, use any method that it can devise to get information to the inquirer. For these special personal services fees are charged sufficient to cover the cost of the time spent on them. The present price for searching is $1.50 an hour; for copies, 25c. a page, and for translations from $3.50 upwards a thousand words. Some 2200 inquiries have been handled in the three years that this service has been in operation.

Tests of Large Brick Piers

A study of the strength of large brick piers has been published by the United States Bureau of Standards, Washington, D. C., under the title, "Compressive Strength of Large Brick Piers." It is written by J. G. Bragg, assistant physicist of the bureau. Forty-six piers, 2½ x 2½ ft. x 10 ft. high, were tested, and also four other piers of the same cross-section and half the height. Two or more grades of brick were used from each of four districts east of the Mississippi River. Three kinds of mortar and three grades of bond and workmanship were employed. The paper by Mr. Bragg first outlines four earlier investigations on the strength of brick piers, then describes the investigations reported in his paper, and finally discusses the results of the later tests. The type of failure observed in the present investigation, Mr. Bragg states, "is in agreement with previous studies of the compressive strength of brick masonry." Some conclusions are drawn from the results of this latest investigation and of the earlier investigations as regards various methods of laying the brick, the introduction of wire mesh at the joints, the thinness of the mortar joints, and the kind of mortar used. Copies of the bulletin may be obtained from the Bureau of Standards, Washington, D. C., without charge, or from the Superintendent of Documents, Washington, D. C., for 10c. each.

The Proposed Arizona Water Code

A brief for water-right legislation in Arizona similar to the code of Wyoming, Oregon and a number of other states in the irrigated area has been written by Prof. G. E. P. Smith, irrigation engineer, University of Arizona, and issued as a circular by the extension service of the College of Agriculture (Tucson, Ariz.). The proposed code was introduced in the last legislature, but was not enacted. It is expected that it will be reintroduced in the next legislature. Professor Smith outlines briefly the proposed legislation and discusses some features of the codes of the other states.

PUBLICATIONS RECEIVED

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be obtained without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other persons indicated.]

THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. TRANSACTIONS FOR 1917-18—Bloomington, Ill.: The Society, Charles Carroll Brown, Secretary. Paper; 6 x 9 in.; pp. 239; illustrated.

AMERICAN RAILWAY ENGINEERING ASSOCIATION: Proceedings for 1918, Vol. 19—Chicago: The Association. Paper; 6 x 9 in.; pp. 1569; illustrated.

ANALYSIS OF THE LAWS AFFECTING MUNICIPAL AND COUNTY FINANCES AND TAXATION: Published by The Commission for the Survey of Municipal Financing of New Jersey—By Arthur N. Pierson, Author of the Laws. Trenton, N. J.: The Commission. Paper; 6 x 9 in.; pp. 117.

BOILER AND FURNACE TESTING—By Rufus T. Strohm, Associate Editor of *Power*. Washington, D. C.: Bureau of Conservation. Paper; 6 x 9 in.; pp. 20; illustrated. Upon application copies may be obtained free of charge from the administrative engineer of the state in which applicant resides, or, Washington, D. C.: Conservation Bureau of the United States Fuel Administration.

CANTONMENT CONSTRUCTION—By Morris Knowles, Consulting Engineer, Pittsburgh; Supervising Engineer, Camp Meade and Camp McClellan. Reprinted from the *Proceedings* of the Engineers' Society of Western Pennsylvania. Pittsburgh, Penn.: The Society. Paper; 6 x 9 in.; pp. 24; illustrated.

THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING: Twelfth Annual Report of the President and

of the Treasurer. New York: The Carnegie Foundation. Paper; 7 x 10 in.; pp. 146. Copies furnished upon request.

COMMERCIAL ARBITRATION AND THE LAW—By Julius Henry Cohen, Author of "Law and Order in Industry," "The Law: Business or Profession?" "A League to Enforce Industrial Peace." New York: D. Appleton and Co. Cloth; 6 x 9 in.; pp. 329; $3.

COMPARISON OF WORKMEN'S COMPENSATION LAWS OF THE UNITED STATES UP TO DECEMBER 31, 1917—By Carl Hookstadt. Washington, D. C.: Bureau of Labor Statistics. Paper; 6 x 9 in.; pp. 101; with tables.

ECONOMIC OPERATION OF STEAM TURBO-ELECTRIC STATIONS—By C. T. Hirshfeld and C. L. Karr. Washington, D. C.: Bureau of Mines. Paper; 6 x 9 in.; pp. 29; illustrated. 5c. from Superintendent of Documents.

ENGINEERING PRACTICE: The J. E. Aldred Lectures, 1917-18—Baltimore, Md.: The Johns Hopkins University. Paper; 6 x 9 in.; pp. 236; illustrated. $1.

Among the nine lectures in this series were: "The Relation between Civil Engineering and Military Engineering," by Maj. Gen. William M. Black; "The Development of Concrete Road Construction," by Arthur N. Johnson, consulting highway engineer; "The Control of Stream Pollution," by Earle B. Phelps, Hygienic Laboratory, American Public Health Service, Washington, D. C.; "The Manufacture of Structural Steel," by Bradley Stoughton, secretary, American Institute of Mining Engineers.

EVENING INDUSTRIAL SCHOOLS—Washington, D. C.: Federal Board for Vocational Education—The Board. Paper; 6 x 9 in.; pp. 54.

EXCESS CONDEMNATION: Why the City of Chicago Should Have the Power, in Making Public Improvements, To Take Property in Excess of Actual Requirements; Lessons to be Drawn from Certain Unfortunate Aspects of the Twelfth Street and Michigan Avenue Widening Projects and the Proposed Ogden Avenue Extension—Chicago: Chicago Bureau of Public Efficiency. Paper; 6 x 9 in.; pp. 58; illustrated.

THE FACTOR OF SAFETY OF WIRE ROPES USED FOR WINDING IN MINE SHAFTS—By J. A. Vaughan, Chief Inspector of Machinery, Department of Mines and Industries. Reprinted from the *Journal* of the South African Institution of Engineers. Johannesburg, South Africa: The Author. Paper; 7 x 10 in.; pp. 11; illustrated.

FINANCIAL STATISTICS OF CITIES HAVING A POPULATION OF OVER 30,000, 1917—Washington, D. C.: Bureau of the Census. Cloth; 9 x 12 in.; pp. 369.

THE FLORIDA TANK PRIVY—By George W. Simons, Jr., Chief Sanitary Engineer, State Board of Health. Jacksonville, Fla.: The Author. Paper; 6 x 9 in.; pp. 7; illustrated.

HIGHWAY COST KEEPING—By James J. Tobin and A. R. Losh, U. S. Engineer Economists, Reviewed by Halbert P. Gillette, Consulting Cost Engineer. Washington, D. C.: United States Department of Agriculture. Paper; 6 x 9 in.; pp. 52; illustrated. 10c., from Superintendent of Documents.

Gives a detailed classification of items under the four main heads of labor, materials, service of plant and equipment, and general expense or overhead. A code number is assigned for each item and complete cost-account forms to be used with the code numbers are suggested. An appendix contains various conversion tables to facilitate computation of quantities and costs.

HOW TO IMPROVE THE HOT-AIR FURNACE—By Charles Whiting Baker. Washington, D. C.: Bureau of Mines. Paper; 6 x 9 in.; pp. 20. 5c., from Superintendent of Documents.

LOW-RATE COMBUSTION IN FUEL BEDS OF HAND-FIRED FURNACES—By Henry Kreisinger, C. E. Augustine and S. H. Katz. Washington, D. C.: Superintendent of Documents. Paper; 6 x 9 in.; pp. 52; illustrated. 10c.

THE NATIONAL FIRE PROTECTION ASSOCIATION: Proceedings for 1918—Boston, Mass.: The Association—Paper; 6 x 9 in.; pp. 294.

NEW JERSEY BOARD OF PUBLIC UTILITY COMMISSIONERS—Financial and Miscellaneous Statistics Compiled from the Annual Reports Made by Public Utilities To the Board, 1916—Trenton, N. J.: The Board. Cloth; 6 x 9 in.; pp. 222.

NEW JERSEY BOARD OF PUBLIC UTILITY COMMISSIONERS Report for 1917—Trenton, N. J.: The Board. Cloth; 6 x 9 in.; pp. 236.

OUR NATIONAL FORESTS: A Short Popular Account of the Work of the United States Forest Service on the National Forests—By Richard H. Doual Boerker, Arboriculturist Department of Parks, City of New York. New York: The MacMillan Co. Cloth; 6 x 9 in.; pp. 238; illustrated. $2.50.

RAND WATER BOARD: Report for 1918 to the Honourable the Minister for the Interior, Union of South Africa. Johannesburg, South Africa: The Board. Paper; 9 x 12 in.; pp. 37; illustrated.

THE RESULTS OF MUNICIPAL ELECTRIC LIGHTING IN MASSACHUSETTS—By Edmond Earle Lincoln, Instructor in Economics, and Tutor in the Division of History, Government and Economics, Harvard University. Boston and New York: Houghton Mifflin Co. Cloth; 5 x 8 in.; pp. 478; illustrated. $3.

SAVING COAL IN BOILER PLANTS—By Henry Kreisinger. Washington, D. C.: Department of the Interior. Paper; 6 x 9 in.; pp. 24; illustrated. 5c., from Superintendent of Documents.

STANDARD SPECIFICATIONS FOR QUENCHED AND TEMPERED CARBON-STEEL AXLES, SHAFTS, AND OTHER FORGINGS FOR LOCOMOTIVES AND CARS: Text as Adopted by the American Society for Testing Materials; Spanish-English Edition, Prepared under the Supervision of the Bureau of Standards, S. W. Stratton, Director. Washington, D. C.: Bureau of Foreign and Domestic Commerce. Paper; 6 x 9 in.; pp. 21. 5c., from Superintendent of Documents.

STATE ENGINEER AND SURVEYOR OF THE STATE OF NEW YORK: Report for 1917—By Frank M. Williams, State Engineer and Surveyor. Albany, N. Y.: The Author. Cloth; 6 x 9 in.; pp. 382; illustrated.

STEEL SHIPBUILDER'S HANDBOOK: An Encyclopedia of the Names of Parts, Tools, Operations, Trades, Abbreviations, etc., Used in the Building of Steel Ships—By C. W. Cook, M. A., B.S. in C.E., Jun. M. Am. Soc. C. E. New York and London; Longmans, Green and Co. Leather; 5 x 7 in.; pp. 123; illustrated. $1.50 net.

TESTS TO DETERMINE THE RIGIDITY OF RIVETED JOINTS OF STEEL STRUCTURES—By Wilbur M. Wilson, Assistant Professor of Civil Engineering, and Herbert F. Moore, Research Professor of Engineering Materials, Urbana, Ill., Engineering Experiment Station. Paper; 6 x 9 in.; pp. 55; illustrated.

WAR TIME CONTROL OF INDUSTRY: The Experience of England—By Howard L. Gray, Professor of History in Bryn Mawr College. New York: The MacMillan Co. Cloth; 6 x 9 in.; pp. 304. $1.75.

SOCIETY SERVICE

A Section Dealing with the Results of Teamwork by Technical Men

St. Louis Club Reports to Commerce Body on Concrete Ships

Coöperation between the St. Louis Engineers' Club and the Chamber of Commerce is such that the war board committee of the chamber recently asked for and obtained a report, which was favorable, on the feasibility of concrete ship building in St. Louis. Briefly, the report states that suitable yards can be economically developed; that all materials are available without adding a burden to transportation; that the draft of a 5000-ton concrete ship is 8 ft., the limiting depth of channel to Cairo, but that heavier ships could be lightered to Cairo by pontoons at a cost of only $500 per trip; that the handicap of cold weather is largely offset by a superior supply of labor and material; that engines and boilers can be built in St. Louis shops without interference with present war work. H. C. Toensfeldt was chairman of the committee.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Mechanical Engineers Organized for Reconstruction

Sir—Responding to your editorial on p. 695 of your Oct. 17th issue asking which society will be first in reconstruction work, I am pleased to say that since February the American Society of Mechanical Engineers has had an active committee on war industries readjustment, working in coöperation with the War Industries Board, Resources and Conversion Section, of which Charles A. Otis is chief.

Whereas the present activities of our committees have had to do with adjustment for the purpose of winning the war, you can easily see that we had in mind the conversion back again to a peace basis as soon as the work of winning the war ceased, and for a month or more we have already been planning the reconstruction program.

Utilizing our local sections organization, President

Charles T. Main has appointed the following members of the society to act as its representatives on each of the regional committees of the Resources and Conversion Section of the War Industries Board: Atlanta, Robert Gregg; Baltimore, William W. Varney; Birmingham, W. P. Caine; Boston, A. C. Ashton; Bridgeport, Harry E. Harris; Chicago, A. D. Bailey; Cincinnati, Fred A. Geier; Cleveland, F. H. Vose; Dallas, A. C. Scott; Detroit, G. W. Bissell; Kansas City, J. L. Harrington; Milwaukee, W. M. White; New York, G. K. Parsons; Philadelphia, C. N. Lauer; Pittsburgh, Ivar Lundgaard; Rochester, F. W. Lovejoy; St. Louis, R. H. Radcliffe; St. Paul, Oliver Crosby; San Francisco, B. F. Raber; Seattle, R. M. Dyer.

The central committee consists of G. Kingdon Parsons, chairman, 29 Pine St.; Fred A. Scheffler, 85 Liberty St.; and Erik Oberg, 140 Lafayette St., all of New York City. CALVIN W. RICE,

Secretary, American Society of Mechanical Engineers.

New York City.

Give the Technical Men a Chance

Sir—There are in the employment of the railroads of our country many technical men who would develop into excellent operating officials if they were given a chance. Some of the Eastern railroads appreciate the value of technical men in the operating department. The practice in this respect on many Western railroads is quite the reverse; in fact, the technical men are too often considered as only draftsmen, surveyors and mechanics, and not as competent railroad men.

The average technical man engaged in railroad work has spent four years in high school, also the same amount of time at some university or technical school preparing a broad foundation for the future. In many instances the state as well as the Federal Government has partly paid for his education, that he may be of greater value to the country in general. He has usually spent considerable time in charge of construction and maintenance work. This work has given him an insight into many railroad problems, including operation and the direction of men.

The incentive for technical men to enter railroad employment may not continue unless they receive more of a chance in the future, especially by Western railroads, to enter the operating department. The large construction problems on the Western railroads formerly attracted technical men to the railroads. Many of the larger construction problems have been solved, whereas there remain many problems of maintenance and operation that require investigation and study. The number and the compensation of positions in the operating department, together with the opportunity for advancement to the higher executive positions, surely would be an incentive to high-class technical men to enter railroad work.

Recently the following incident came to my attention, and may serve to illustrate my point of view. An engineer, by ability and hard work, had advanced to an important position in the engineering department of a large railroad. The outlook ahead in his department was not very bright—not that he was not capable, but because there were only a few higher positions ahead of him in that department. A large contracting firm realized his value and obtained his services. The railroad lost a valuable man, one who was thoroughly competent to have been advanced as an operating official, yet the railroad did not know his value.

A plan could be developed by the railroads so that full advantage of all latent ability in the engineering department could be obtained. Technical men could be classified according to their education, experience and ability. To the men who have reached the grade of assistant engineer or master mechanic might be offered the first chance to enter the operating department. They could be started as trainmasters and assistant superintendents, or as understudies of superintendents of important divisions. The classing of technical men should not be left entirely to any one individual, but rather to several, some of whom know his qualifications from personal contact.

I do not believe that all technical men will make excellent operating officials. Some men may be better suited for the engineering department. On the other hand, it stands to reason that the man who has technical training, combined with railroad experience, will, in general, be of much more value than one whose training has been entirely practical. There are many positions in the operating department that should be open to technical men. I believe that if opportunities were afforded to technical men in the operating department they would soon prove their value and advance to the higher executive positions. F. D. YEATON.

Oak Park, Ill.

Norwich the Oldest Civil Engineering Institution in the Country

Sir—In view of statements made in the bulletin entitled "A Study of Engineering Education," by Dr. C. R. Mann, Norwich University lays claim to being the oldest civil engineering institution in the country. Dr. Mann makes the statement that Rensselaer Polytechnic Institute, Lawrence Scientific School and Sheffield Scientific School were the only engineering institutions opened before the Civil War.

As early as 1825, Norwich University was giving a full course in civil engineering, and has maintained such a course from that date to the present day. Norwich graduates were pioneers in early engineering. The first steam railroad in this country was built by a Norwich graduate, Moncure Robinson, in 1827-8. Among many prominent Norwich engineers we may mention Alfred W. Craven, '25, one of the founders of the American Society of Civil Engineers; Gen. Grenville M. Dodge, '51, who was chief engineer of the Union Pacific R.R. during the period of construction, made surveys of nearly 200,000 miles of railroad and actually constructed 20,000 miles; William Parker, '25, who was consulting engineer on the first suspension bridge at Niagara Falls; Randolph Coyle, '28, who was engineer in charge of construction of the bridge over the Potomac River at Little Falls, Va., in the year 1857; Leonard J. Wright, '52, who was on the construction of the Poughkeepsie bridge; and a large number of engineers who took important part in the early engineering of the country, a record which has been maintained.

Northfield, Vt. ARTHUR E. WINSLOW,

Professor of Civil Engineering, Norwich University.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Inner Body on Rollers Converts Fixed-Body Truck Into Dump Truck

By C. F. Lewis

Highway Engineer, Office of Public Roads, Washington, D. C.

STANDARD fixed-body Army trucks were successfully converted, by inner bodies on rollers, into end-dump trucks, for handling materials for several miles of roads built recently on a large Government reservation. As is shown quite clearly by the accompanying views, an inner body of the proper size to fit loosely in the standard truck body was constructed. Realizing the strain to which this inner body would be subjected in loading and dumping, it was built of 2-in. planks and was well braced with vertical sidepieces and longitudinal steel bands. The steel bands not only strengthened the body, but prevented the side braces from catching when the body was slipped back into position after dumping. On the under side of the body, in the view showing the body in place, can be seen the ends of three longitudinal planks. Each of the two outer planks rests on the rollers of a section of roller gravity conveyor. Mounted on the rear edge of the truck body is a roller over which the center plank passes. Around this roller, on each side, is a fixed pipe, flanged, over which the side planks slide, being guided by the flanges. The body is held in place by a ¾-in. pin passing through loops in the front end of the inner body, the end of the pin being held by a block fastened to the floor of the standard truck body.

A slight jerk of the truck usually suffices to start the body moving on the rollers. After moving a varying distance, depending on the position and the amount of the load, the inner body drops to the dumping position shown. Attached to the under side of the center plank, and forward of the center of the body, is a strong hook which catches on the roller guide at the rear of the truck and prevents the inner body from dropping out of the truck as the latter moves forward discharging and spreading the load. Two men can easily lift the rear end of the body and roll it back into place after dumping.

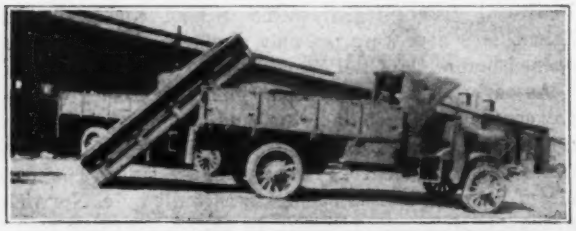
This construction, devised by Capt. A. Rogers, Q.M.C., U.S.A., supervising road construction for the Quartermaster Corps, and R. Philpot, road superintendent for the contractor, permitted the use of available fixed-body Army trucks, and also released the labor which would have been required to unload the truck by hand. The same arrangement can be applied to other types of trucks, changing the details to fit the conditions.

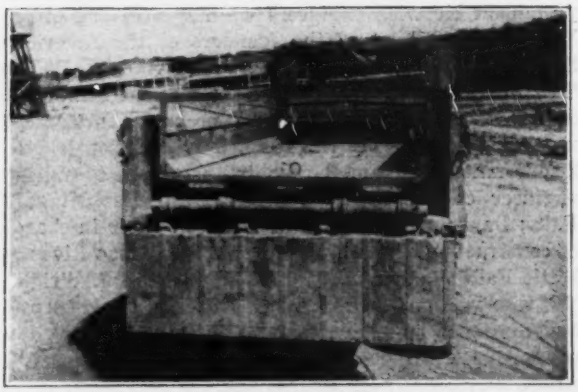
Other Articles of Interest to Contractors In This Issue:

Central Plant for Sharpening Drill Steels Saves Money in Quarrying — Page 929

Some Heavy Fitting-Out Cranes—II. Cantilever and Jib Travelers at Newark Bay and Bristol — Page 937

One Set of Wood Forms Used Three Times Completes Concrete Foundry — Page 950





INNER BODY SLIDES OUT OF TRUCK ON ROLLERS TO INCLINED DUMPING POSITION

Force Pump Effective in Pulling Piles

By C. H. Cotten

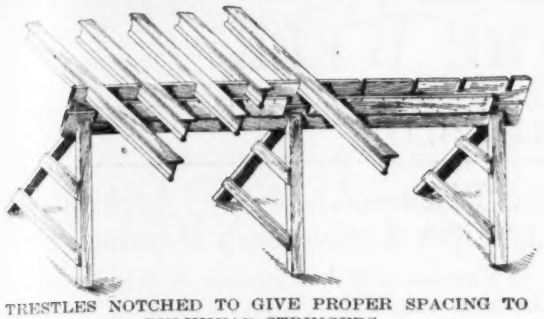
Lieutenant, Corps of Civil Engineers, United States Navy

TO PREPARE the site of a new quay wall for pile-driving and dredging operations, it was necessary to pull a number of piles which had supported a platform under an old sea wall. The piles had been driven 35 ft. below cutoff through silt, mud and stiff clay.

A chain attached to the pile was secured to blocks and tackle fastened to the piledriver leads. A duplex force pump with a 2-in. suction, 1-in. steam connection and a 1-in. discharge was hooked up to a boiler on the driver. About 30 ft. of steam hose with 25 ft. of 1-in. pipe on the end was used for discharge. A strain was taken on the chain, and the pipe end of the discharge line was forced in the mud alongside of the pile. The mud and clay was loosened for a depth of 20 to 25 ft., and very little pulling was needed to bring the pile up.

Ship Bulkheads Assembled on Trestles Notched to Take Stringers

IN ASSEMBLING the bulkheads for the 9000-ton steel ships it is building, the Groton Iron Works, of Groton, Conn., makes use of wooden trestles or horses,

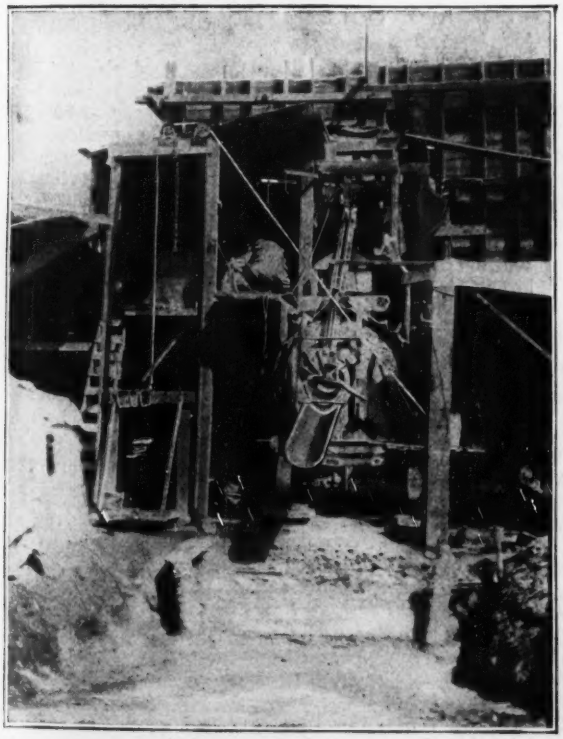


TRESTLES NOTCHED TO GIVE PROPER SPACING TO BULKHEAD STRINGERS

as shown in the accompanying sketch. These trestles carry a stringer notched in the top at the proper spacing to take the stringers of the bulkhead. The horses are set up in the pre-assembly yard, spaced about 10 ft. apart, leveled up and with the notches lined up. The steel bulkhead stringers are then placed in the notches which have been cut so that the upstanding flanges are level. On the stringers so placed the plate locating and riveting are readily done.

Mixer Engine Operates Cement-Bag Elevator

CEMENT for concrete pavement base at Edison Park, Ill., was hoisted about 10 ft., to mixer-charging level, by an elevator operated by the mixer engine. The mixer was set at ground level under elevated sand and stone bins, as the picture shows. A cement house was built at the ground level close to one side of the bins. The mixer was a standard paver set as a stationary mixer by blocking the wheels and supporting the carriage by jacks. It had, therefore, a high charging level to which the cement had to be raised.

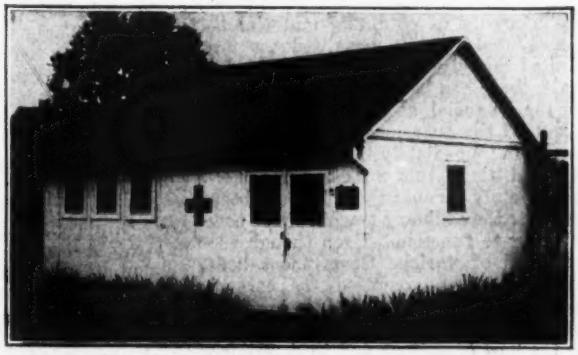


ELEVATOR CAGE OPERATED BY MIXER ENGINE HOISTS CEMENT BAGS

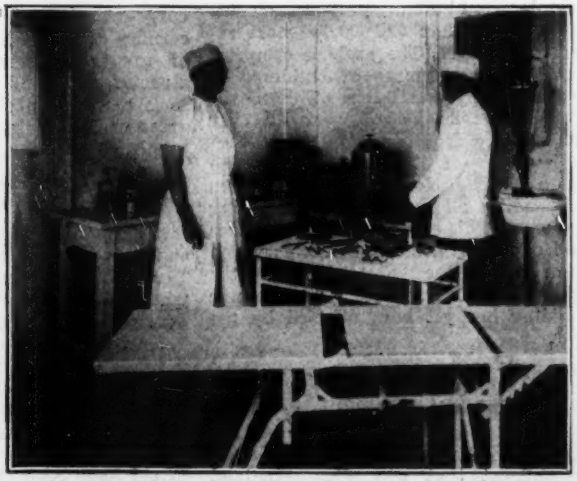
As shown in the view, the cage and guides were located between the mixer and the cement house. A rope from the mixer engine hoisted and lowered the cage, as illustrated. Concrete was carried away in motor trucks which backed into the pit shown in front of the mixer. The contractors for the paving work were R. F. Conway & Co., Chicago. Ill.

Eight Hundred Dollars for Field Hospital

FIELD hospitals, costing fully equipped less than $825, and entirely adapted for use on construction work, are employed by the Ralston Steel Car Co., Columbus, Ohio. The building is a one-story, steel-clad, sectional structure set on a concrete floor. It is 15 x 24 ft., and has two rooms. One, into which the entrance opens is fitted for treating minor injuries, and the other is fully equipped for more serious operations. The exterior and the interior are painted. The building is piped for water, steam heat and gas, and is wired for electric lights. Including necessary furniture and appliances, it cost $823.73 in 1917. Itemized, the costs were: Building with concrete floor, $484.14; steam heating, $102.54; water, $9.59; sewerage, $29.40; gas, $4.01; electric lighting, $21.55; equipment, $172.50; total, $823.73.



SECTIONAL BUILDING MAKES ATTRACTIVE HOSPITAL



EQUIPMENT FOR FIRST-AID AND EMERGENCY OPERATIONS

NEWS OF THE WEEK

New York, November 21, 1918

Nonwar Building Revival Moving Slowly

Prospects of Increases in Construction, Due To Removal of Priorities, But Little Work Yet Reported

Actual results from the removal of building restrictions on nonwar work have not yet begun to appear. Following the War Industries Board's circular No. 57, which exempted after Nov. 12 a number of building activities from the necessity of obtaining material licenses, and further permitted the unlimited manufacture of building materials, there has been much talk, mostly in the financial sections of the daily press, of the enormous amount of construction immediately to be undertaken. So far little of this work has materialized, mainly because there has not been time for the ordinary machinery of new building to function. Even though the approval of various Government bodies is not now required for certain work, the interests contemplating new construction have to adjust themselves to the new conditions and to determine upon the present desirability of this construction and the details of its design, if thought desirable. Furthermore, much new work, under the recent order, still has to go through the state Councils of Defense, which takes time, especially as these local bodies are not yet completely advised concerning their proper policies.

There are, however, several indications of increased building operations. The War Industries Board announces that deferred building projects amounting to more than $20,000,000 were released Nov. 12. The projects comprise a very large number of buildings of comparatively small size. This means a wide distribution of work all over the country from coast to coast.

Secretary of the Treasury McAdoo also rescinded, Nov. 16, previous orders suspending all public building during the war. This applies to all post offices and other Government buildings which come under the jurisdiction of the Supervising Architect. No specific building has yet been affected by the order.

Portland Votes for $5,000,000 Harbor Improvement Bonds

The city of Portland, Ore., at the recent election, passed the charter amendment that will allow Portland to issue bonds in the sum of $5,000,000 for harbor improvements. Among the improvements contemplated are the building of a 12,000-ton dry dock, enlarging the present piers, and erection of large coal docks.

Ship Problems Discussed by Naval Architects at Twenty-Fifth Anniversary Meeting

Electric Welding in England and America—R. J. Wig Reports the Concrete Ship a Structural Success

At its 25th meeting since the society's formation in 1893, the Society of Naval Architects and Marine Engineers last week elected its fifth president. Admiral W. L. Capps succeeds Lieutenant-Commander Stevenson Taylor, who has served the society for nearly ten years. The meeting was held at Witherspoon Hall, Philadelphia, on Nov. 14 and 15. About half the technical program was occupied by subjects connected with the problems of the present shipbuilding epoch. Most prominent were electric welding, concrete-ship construction, and simplified or straight-line shape for ships. Wooden shipbuilding, the unsinkable ship, the work of the Newark Bay and Hog Island shipyards, and launching methods, also found representation in technical papers.

Secretary of the Navy Speaks

Over 800 members of the society, and other shipyard men, gathered at the annual banquet, held Nov. 15. Josephus Daniels, secretary of the navy, expressed the thanks of the administration to the shipbuilders for their large contribution to victory. "No man now living will see, unless wisdom departs from us, the Government retire from the business of building and operating cargo-carrying ships," he said, concerning our maritime future. A navy of great power is also to be constructed, according to Mr. Daniels, who feels certain that before Mar. 4 Congress will authorize the new three-year program asked for.

President Taylor on Shipbuilding

Strongly voicing his faith in the future development of American shipping and shipbuilding, President Stevenson Taylor, in the annual address, affirmed that the nation would find ways to deal with each of the obstacles confronting it, as soon as the obstacles reveal themselves. Figures show that a shortage of 14,000,000 tons of shipping exists at the present time, there being only 41,000,000 tons of shipping at hand as against a tonnage of 55,000,000 that should have been reached by this time in the normal development of ocean commerce (the figures are in gross register tons). The United States will soon be the possessor of 10,000,000 tons of shipping, said Mr. Taylor. Referring to the numerous instances of phenomenal performance in shipbuilding, whether in speed of completing a given ship or in number of rivets driven in a day, he expressed the view that all of these records had been artificially prepared for, and that moderate performances steadily maintained are of greater value; yet he paid special tribute to the maintained reduction in time of completion of ships as evidence of distinct advance in the shipbuilding art.

Electric Welding in Ship Construction

Tests of the strength of welded parts of ships were carried out for the technical committee of Lloyds' Register of Shipping in England a short time ago and were reviewed by H. Jasper Cox, of Lloyds' Register, in a paper entitled "The Application of Electric Welding to Ship Construction." Briefly, the welded pieces gave good strength and endurance results, though in bend tests ½-in. plate failed at a bend of 80° and 1-in. plate at 20°, while unwelded ship steel could be bent 180°. Experiments which are being carried out in this country by the welding committee of the Emergency Fleet Corporation were also referred to by the author. A design by J. W. Isherwood for a longitudinally framed vessel with welded connections, and a design by C. P. M. Jack for a welded ship with transverse plating, were shown. The British "welded ship," it was stated, is a cross-Channel barge of 275 tons, and no trial in sea service is yet available to demonstrate the robustness of welded plate and frame connections. H. M. Hobart, H. A. Hornor, J. W. Isherwood and others discussed the paper. Mr. Hornor, speaking for the Fleet Corporation, emphasized the element of skill involved in successful welding; craftsmen in welding must be developed virtually as artists. The subject was discussed mainly from the viewpoint of continuous welding, spot welding finding little favor.

Concrete Ship Is a Structural Success

In a full review of the Emergency Fleet Corporation's work in developing concrete ships—as abstracted briefly on p. 903 of last week's issue—R. J. Wig, head of the Concrete Ship Divi-

(Continued on page 960)

World Needs Twenty Million Tons of Shipping

Chairman Hurley of Shipping Board Says Shortage Is Eight Times Last Year's Production

Large demands will be made on the shipbuilding industry of the country for years to come, according to a statement issued by Edward N. Hurley, chairman of the United States Shipping Board, on his departure for Europe, Nov. 15, to arrange ship-administration details. He predicted an increase in the need for new ocean tonnage saying:

"The need for ships was never so great as it is now, and this demand will continue for years, until the world shall catch up with the tonnage it requires to transact its normal commerce. At present we are nowhere near providing that urgently needed tonnage. Ship construction needed to make up for losses and for the lapse in meeting the normal growth of shipping will be about 20,000,000 dead-weight tons, or eight times the total of seagoing-ship construction in the United States during the calendar year 1917.

"The 160 new shipyards which have been created under the Emergency Fleet Corporation have been busy day and night. There are now about 386,000 employees in these shipyards and 250,000 in allied trades. If, with this immense force working at top speed, our ship production is each year less than a tenth of the 20,000,000 dead-weight tons the world will imperatively need by 1920, it is clear that instead of being at the end of shipbuilding requirements we are only at the beginning.

"In 1914, the seagoing American merchant marine comprised only 391 vessels, of 1500 dead-weight tons and over, totaling 1,660,679 dead-weight tons. Today our seagoing fleet, of 1500 dead-weight tons and over, totals 1389 vessels of 7,043,210 dead-weight tons. All told, within the jurisdiction of the Shipping Board, including requisitioned and chartered ships, there are, at the present time, 2312 seagoing vessels totaling 10,114,334 dead-weight tons. Since August, 1917, nearly 4,000,000 dead-weight tons—to be exact, 3,912,836 dead-weight tons—of new shipping have been launched, and 2,894,510 dead-weight tons have been completed and delivered for service. Nearly nine times as much seagoing tonnage has been built in the United States, this year, as in the banner pre-war year of American shipbuilding. This is only the beginning of a program calling for 25,000,000 dead-weight tons."

Defines Technical Engineer

To facilitate the work of the engineering division of the United States Employment Service, it was necessary to have a workable definition of the term engineer which would be all-inclusive of the many branches of technically trained engineers and still distinguish him from the engine driver or flat janitor. The definition, which is the work of a committee of engineers appointed by the Service and headed by W. H. Finley, president of the Chicago & Northwestern Ry. Co., is as follows:

"An engineer is one who economically directs man-power and, by scientific design, utilizes the forces and materials of nature for the benefit of mankind."

United States Highways Council Lessens Its Activity

A telegram has been sent out by the United States Highways Council, announcing a curtailment in its control of highway construction and maintenance. No further applications need be made to the council for release for highway materials, and those desiring them should follow the same procedure as before the war. Even in cases where the council has refused permission to build highways this refusal is no longer in force; but the telegram does not affect the issuance of bonds for new construction, as this phase of the highway problem has been taken care of by the Capital Issues Committee. The text of the telegram, which was sent to all state highway departments, follows:

"The United States Highways Council announces that no further applications need be made to it for approval of highway projects, that disapprovals previously made and revoked, and pending applications will require no further action. Procedure as to securing materials and transportation should follow normal practice.

"The removal of restrictions does not affect highway bond issues, as this question of finance is by law under control of the Capital Issues Committee.

"State highway departments will not be asked to submit programs for next year's work."

This action has been taken as a result of the general release of bituminous road materials by the Fuel Administration and the general release of other materials, except steel, by the War Industries Board. The use of steel in highway structures is still under restriction, and it is impracticable at this time to furnish information concerning the future control of the use of this material for road purposes.

Housing Association to Hold Conference in Boston

The National Housing Association will hold its seventh conference on housing in America at the Copley Plaza Hotel, Boston, Nov. 25-27. Among the subjects to be discussed are "Government Ownership of Homes," "Reconstruction and Housing," "Rent Profiteering," "Labor and Housing" and "Management of Industrial Housing Projects."

Reconstruction Discussed at City Managers' Convention

Problems of reconstruction and measures for insuring a safe return of cities to a peace basis held a prominent place in the discussions at the fifth annual convention of city managers held at Roanoke, Va., Nov. 6-8.

On the first afternoon of the convention Myron H. West, president of the American Park Builders' Association, delivered an address on "City Planning for After-War Conditions."

At a dinner given by the Roanoke Chamber of Commerce Louis E. Wilson, New York City, general manager of the American City Bureau, delivered a paper on "Establishing and Maintaining the Commission-Manager Government." At another session of the convention R. S. Childs, United States War Department, contributed a paper on "Uncle Sam's Call to City Managers," advocating careful planning for the return of the city to a peace basis.

At a luncheon session O. E. Carr, city manager, Springfield, Ohio, discussed "Progress, Prospects and Pitfalls of the New Profession," basing his conclusions on five years' experience in the management of cities. Mr. Carr pleaded for a sane working out of the manager idea and careful administration.

The last day of the convention included the most important round-table discussion of the meetings. Duties and problems of a city manager, the finance department, the public welfare department, the public service department and the public utilities department were included in the subjects of discussion.

The following officers were elected: President, C. A. Bingham, Waltham, Mass.; vice-president, H. H. Sherer, Glencoe, Ill.; secretary and treasurer, H. G. Otis, Auburn, Maine.

Atlantic Coast Shipbuilders Meet, With Piez in Chair

Under the chairmanship of Charles Piez, vice-president of the Emergency Fleet Corporation, the Atlantic Coast Shipbuilders' Association held a quarterly meeting at the Bellevue-Stratford Hotel, Philadelphia, Nov. 14. On invitation, most of the members of the Society of Naval Architects and Marine Engineers were present at the meeting. No association business was transacted, but the present shipbuilding situation was discussed quite openly. Mr. Piez and Admiral F. T. Bowles, Lieutenant Commander Stevenson Taylor and Homer L. Ferguson, of Newport News, were among those taking part in the discussion.

Mr. Piez said that no cancellation of steel-ship contracts was in prospect. At only one yard have orders been canceled, and even that yard has enough work ahead to run well into 1920. All other yards have enough Emergency Fleet contracts to keep busy throughout 1919 and through part of 1920.

Economy will now have to take the place of speed in the shipyard, he said, and this means a return to the peace-time relations of shipyards as soon as possible. The only opportunity for re-adjustment probably is in the sizes of the ships to be built.

Admiral Bowles and Lieutenant Commander Taylor spoke in favor of an American registry for shipping. A bill has already been introduced in Congress to provide the machinery for this.

Engineering Education Society To Meet with British Mission

A joint meeting of the British educational mission to the United States and the Society for the Promotion of Engineering Education will be held at the Massachusetts Institute of Technology, Cambridge, Mass., Dec. 6-7. The principal topics for discussion will be "The Organization of Engineering Education in Great Britain and the United States," "The Effect of the War on Engineering Education in Great Britain and the United States" and "The Liberal Element in Engineering Education."

Each discussion will be led by a member of the British mission representing Great Britain and by a member of the Society for the Promotion of Engineering Education, including Charles S. Howe, president, Case School of Applied Science; Dr. C. R. Mann, Massachusetts Institute of Technology and Carnegie Foundation for the Advancement of Teaching, and Prof. George F. Swain of Harvard University.

United States Public Health Reserve Authorized

Congress has passed and the President has signed a joint resolution providing for a reserve of the United States Public Health Service. The resolution was originally introduced in Congress in June, 1917. Its scope was subsequently enlarged, but the resolution as finally passed seems to be more restricted than in its earlier stages. It authorizes the President to commission, for five years, officers in the United States Public Health Service Reserve who pass examinations prescribed by the President, these officers to form "a reserve for duty in the Public Health Service in time of national emergency." None of the officers commissioned shall have higher rank than that of assistant surgeon general. The reserve officers "shall be distributed in the several grades in the same proportion as now obtains among the commissioned medical officers of the United States Public Health Service, and shall at all times be subject to call to active duty by the Surgeon General, and when on such active duty shall receive the same pay and allowances as are now provided by law and regulation for the commissioned medical officers in the said regular commissioned Medical Corps."

National Highways Bill Introduced in Senate

A bill providing for the taking over, improvement, relocation, construction and maintenance of a system of national and state highways, to facilitate the movement of troops, equipment, munitions and supplies, has been introduced in Congress by Senator Chamberlain. The bill if passed will authorize and direct the Secretary of War to take over a comprehensive system of roads throughout the United States, with the primary purpose of maintaining roads for the movement of military forces and equipment.

When the chief consideration, military expediency, has been served, the roads are to be selected further with reference to their utility in the transportation of mail, facilitating interstate and foreign commerce, aiding agricultural and manufacturing pursuits, and promoting the general welfare of the people. The Secretary of War is instructed to confer with the authorities of the several states, to the end that unnecessary duplication of highways may be avoided and that non-military highways may be located strategically wherever such location is reasonably possible.

Engineers Pay Honor to Ambrose Swasey

A dinner in honor of Ambrose Swasey, of Cleveland, who has recently made an additional gift of $100,000 to the Engineering Foundation, as mentioned in *Engineering News-Record* of Oct. 17, p. 735, took place at the Engineers' Club in New York City on the evening of Nov. 14. The dinner was given by the United Engineering Society, and the president of that Society, Charles F. Rand, presided. In his opening remarks Mr. Rand stated that the United Engineering Society, as the representative of the four Founder societies (the several societies of civil, mining, mechanical and electrical engineers) now holds and administers for the benefit of the engineering profession property valued at about $2,700,000.

British Imperial Water-Power

A committee of British engineers headed by Sir Dugald Clerk declares that rapid development of the empire's latent resources is imperative to enable it to recover from the financial losses of the war, and that the cornerstone of such development is an ample supply of cheap power. With the exception of Canada, South Africa, New Zealand and a part of Australia, the committee finds that no systematic attempt has been made even to investigate the latent water-power resources of the British possessions. The committee roughly estimates the potential water power of the Empire at 50,000,000 to 70,000,000 horsepower, only a small percentage of which has been developed.

Naval Architects' Meeting

(Continued from page 958)

sion, led up to conclusions highly favorable to this type of vessel. The new light-weight aggregate has made it possible to reduce the weight of concrete even below the 110 lb. per cubic foot reported heretofore, the present figure being under 100 lb. A weight efficiency of 60% is obtained in a 7500-ton tanker, as compared with 53% for a wood ship and 53 to 56% for a ship of ordinary concrete, steel ships showing approximately 70 per cent.

Considering strength, taking into account calculation as well as the excellent performance of the "Faith," the concrete ship must be regarded as the equal of the steel ship, in Mr. Wig's view. Furthermore, its frictional resistance is no greater than that of the steel vessel. Nevertheless, the future of the concrete ship cannot be predicted at present, as we do not yet know from experience that the saving in first cost can be made large enough to counterbalance the reduced carrying efficiency.

New Shipbuilding Equipment

Larger capacity of yards building naval vessels has been urgently needed during the past few years, in view of the present navy program and that contemplated by the naval authorities for the immediate future. How this requirement is being met was reviewed briefly by Naval Constructor S. M. Henry under the title "Recent Developments in Shipyard Plants." Building berths are laid out for a maximum ship 1000 x 110 ft. The supports are of concrete, with cambered slope averaging [illegible] per foot; bridge cranes over the berths are provided for handling ship material. One building berth of the dry-dock type has been constructed, capable of floating a vessel at drafts up to 20 feet.

Why the "Unsinkable Ship" Sank

Recent dispatches telling of the loss of the "Lucia," a ship fitted with buoyancy boxes according to proposals of W. T. Donnelly, came to notice in connection with a paper by Mr. Donnelly describing the installation. Some 12,000 wooden boxes placed along sides, decks and bulkheads gave this 9600-ton, deadweight, vessel an artificial buoyancy of 5500 tons, providing a reserve of 1140 tons when the entire hold was flooded. The double bottom, the propeller tunnel and the peaks were assumed to remain intact. To refute charges that the ship when flooded lacked stability, the author gave the calculations in his paper. This latter had been prepared before the vessel was sunk.

Straight-Line Ship Forms Found Advantageous

Tests by Prof. H. C. Sadler and T. Yamamoto on models of ships designed with straight-frame shape showed that the propulsive resistance is about the same as that of regular ship-shape models, ranging from 2 to 3% lower to 4 or 5% higher.

According to tank experiments reported by Naval Constructor William McEntee, the best position for the parallel middle body of a 400-ft. cargo ship is that which places its center 43% of the length aft of the forward perpendicular. The length of middle body used in the tests was 33% of the ship's length, which had been found from previous experiments to give the lowest resistance at the speed of freight steamers.

The use of soft wood crushing strips in the launching cradles of heavy ships, to prevent the occurrence of undue concentration of load on the ways at the moment when the stern of the ship enters the water, was recommended by William Gatewood in a paper entitled "Notes on Launching." Edward Hopkins, reviewing the side-launching methods used on the Great Lakes, stated that the only danger in the method lies in giving the ways too small a slope. Practice agrees in making the slope 1¼ to 1½ in. per foot, or twice that used in end launching.

Other Papers and Addresses

The plant at which the air rock drill was developed and Ericsson's "Monitor" built, the Delamater Iron Works, was treated in a historical paper by H. F. J. Porter, from its foundation in 1838 to its abandonment in 1890. Some of the methods and work of the Tacoma and Portland yards of The Foundation Co. were described by Carlos de Zafra in a paper entitled "Revival of Wooden Shipbuilding as a War Industry." H. R. Sutphen, in "Structural Steel Standardized Cargo Vessels," described the development of the Submarine Boat Corporation's yard at Newark Bay and the designing and fabricating methods adopted there. Mathematical problems arising in connection with the study of synchronism between engine speed and hull vibration were considered by N. W. Akimoff under the title "Vibrations of Beams of Variable Cross-Sections." The great Hog Island yard was described by W. H. Blood, Jr., in an elaborately illustrated paper.

Serious troubles have been encountered in the operation of turbine reduction gears, it was stated in the discussion of Francis Hodgkinson's paper, "Progress in Turbine Ship Propulsion." W. L. R. Emmet stated that thorough investigation of the troubles is in progress, and a successful solution is hoped for. Excessive tooth pressures are not believed to be a factor, as he has run a gear of the rigid-frame type continuously for 1500 hours at tooth pressures double those recommended by Mr. Hodgkinson.

Reclamation Service Moves Its Washington Office

The United States Reclamation Service has moved its Washington office from Eighth and E Sts. to the sixth floor, west wing, of the Interior Department Building, Nineteenth and F Sts., Northwest.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS; A. Dennis Williams, Morgantown, W. Va., acting secretary, Dec. 9-12, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 West 39th St., New York City; Dec. 3-6, New York.

AMERICAN PUBLIC HEALTH ASSOCIATION; 126 Massachusetts Ave., Boston; Dec. 9, Chicago.

AMERICAN ROAD BUILDERS' ASSOCIATION; 150 Nassau St., New York City; Feb. 25-28, New York City.

The American Road Builders' Association will hold its 16th annual convention in New York City, Feb. 25-28, inclusive. The place of meeting will be the Hotel McAlpin, and the program will include technical sessions every forenoon and afternoon. The machinery exhibit will be omitted, as it was last year, but exhibits by means of photographs and models will be held.

The Detroit Engineering Society was addressed by D. L. Turner, chief engineer of the Public Service Commission, New York City, at the meeting held Nov. 15. Mr. Turner read a paper on "Subways as a Means of Metropolitan Transportation," illustrated with stereopticon views.

The Engineers' Club of Philadelphia will be addressed by Charles N. Knight and the superintendent of the aërial mail service, Washington, D. C., on "Aëronautics and the Aëroplane Service Now in Effect Between Washington and New York," at the weekly luncheon to be held Nov. 26.

The Harvard Engineering Society of New York will hold a meeting Nov. 22. H. E. Breed, first deputy commissioner, New York State Highway Commission, will give an illustrated lecture on New York State's highway system and the problem of motor-truck transportation.

The Colorado Association of Members of the American Society of Civil Engineers held a regular meeting Nov. 16 in Denver, at which Charles W. Comstock spoke on "Development of the Modern Military Rifle." An informal dinner preceded the meeting.

The Engineers' Club of Trenton, N. J., was addressed Nov. 14 by Captain Blaise of the French High Commission to the United States, who spoke on "French Industrial Effort During War." Captain Blaise's address was supplemented by war motion pictures. On account of the influenza epidemic it was necessary to postpone the opening meeting of the club season one month.

Personal Notes

CHARLES P. RICHARDSON, assistant engineer of track elevation of the Chicago, Rock Island & Pacific Ry., has been appointed engineer of water service, succeeding J. M. Brown, whose appointment as corporate engineer of maintenance and construction is noted elsewhere. Mr. Richardson, who was graduated from Dartmouth College, began railway work in 1907 as assistant engineer with the Missouri Pacific R.R. In 1909 he became assistant engineer, and in 1912 he left the Missouri Pacific to take the post from which he is now promoted.

E. L. WILLIAMSON, New York City, has become assistant engineer for the Degnon Contracting Co., in connection with its contract with the Board of Water Supply of New York City, for Shandaken Tunnel.

COL. FREDERICK W. ALSTAETTER, Corps of Engineers, U. S. A., has been appointed engineer of the Southeastern Division, with headquarters at Savannah, Ga., succeeding Col. John Millis, who has been transferred to the office at Chicago, as noted elsewhere.

ERNEST G. WILLEMIN, resident engineer, Michigan State Highway Department, with headquarters at Ionia, Mich., has been commissioned as a first lieutenant in the Corps of Engineers and assigned to duty at Camp A. A. Humphreys, Virginia.

FRANK T. MILLER, office engineer of the assistant to vice-president of the Southern Ry. System, at Washington, D. C., has been appointed engineer in charge of the engineering under the assistant to the president, at Richmond, Va.

JOHN F. GREATHEAD, formerly section engineer for the Public Service Commission on the New York City subways, and division engineer for the city on the Philadelphia subway, has been appointed field engineer at Mare Island, California, in charge of plans and surveys.

M. H. MCLEOD, general manager and chief engineer of the Canadian Northern Ry., with office at Winnipeg, Man., has been appointed vice-president of operation, maintenance and construction, with office at Toronto. He has jurisdiction over the entire Canadian Northern system. Mr. McLeod was born in Scotland in 1857. He was

educated at Franklin, Penn., and entered railway service in 1878 as chainman on the Victoria Ry. For the next 22 years he was on various railroad location and construction in Canada. In 1900 he was appointed chief engineer of the Canadian Northern Ry., and in 1907 he was also made general manager.

JOHN H. SAWKINS has severed his connection with Henry Steers, Inc., contracting engineers, New York City, to become assistant professor in engineering drawing, surveying and descriptive geometry at Union College, Schenectady, N. Y.

WILLIAM C. BEUSCHER, formerly city engineer of West New York, N. J., has been appointed to the staff of the county engineer of Hudson County, N. J.

J. M. BROWN, engineer of water service of the Chicago, Rock Island & Pacific Ry., has been appointed corporate engineer of maintenance and construction.

E. ROY WELLS, civil engineer, Aurora, Ill., will carry on the business of the Wells Engineering Co., in which he was a partner with his brother, Harry L. Wells, whose death is noted in the last column of this page.

COL. JOHN MILLIS, Corps of Engineers, U. S. A., has been transferred from the office at Savannah, Ga., where he has served as engineer of the Southeastern Division since 1916, to the Chicago office.

W. F. RECH has been appointed bridge engineer of the Chicago & Alton R.R. and other railroads in the same Government operating group, with office at Chicago.

S. D. MOSES, resident engineer of the Southern Ry., at Alexandria, Va., has been appointed superintendent of buildings and structures in the office of the assistant to the president, at Richmond, Va.

W. C. WANGLER, assistant city engineer of Dayton, Ohio, is to succeed George F. Baker as bridge engineer for the city engineering department. Mr. Baker has reported for duty at Camp A. A. Humphreys, Virginia, with the rank of lieutenant.

A. J. WHARF, chief engineer of the Peoria & Pekin Union Ry., with office at Peoria, Ill., has been appointed assistant chief engineer of the Chicago & Alton R.R., the Chicago, Peoria & St. Louis R.R., the Peoria & Pekin Union Ry. and the Peoria Railway Terminal, with headquarters at the same point. Mr. Wharf has been chief engineer of the Peoria & Pekin Union for the last five years, prior to which he was with the Union Pacific R.R. for fourteen years. He was graduated from the University of Illinois in 1898.

WALTER H. TAYLOR has been appointed director of public works of Norfolk, Va., by the city manager.

W. E. NICHOLSON, assistant to the chief engineer of the Norfolk Southern R.R., has been appointed chief engineer for the corporation.

OBITUARY

LIEUT. WARD H. REAM, company C, 2nd Battalion, 305th Engineers, was killed in action on the west front Oct. 4. For the past eight years Lieutenant Ream had been a bridge designer for the Delaware, Lackawanna & Western R.R. Co. He had attended the Webb Academy of Naval Architecture, after which he took a post-graduate course at Columbia University.

JAMES C. HALLOCK, formerly deputy chief engineer, Board of Public Works, Newark, N. J., died in Ecuador, Nov. 2, in his 50th year. Mr. Hallock was graduated from the Rensselaer Polytechnic Institute in 1891 and became assistant to the general superintendent, Troy Steel & Iron Co., Troy, N. Y. In 1893 he was employed by the United States Coast Survey Corps, engaged in deepening the channel of the Hudson River. A year later he went to Ecuador as Government engineer and surveyor for the Province of Esmeraldas. In 1895 he went to San Francisco, where he practised as a mining engineer until 1901, when he became general manager for the Southern Exploration & Commercial Co., of Ecuador. Afterward he became director general of public works and chief engineer for the Government of Ecuador. Returning to this country in 1906 he became engineer in charge of the work on the Passaic Valley Flood District Commission, and later assistant chief engineer of the State Water-Supply Commission. He entered the service of the City of Newark in 1909 and became chief deputy engineer for the Board of Public Works in 1910.

A. A. ROBINSON, formerly vice-president of the Atchison, Topeka & Santa Fé Ry., and later president of the Mexican Central Ry., died Nov. 7, at the age of 74, at his home in Topeka, Kan. Mr. Robinson was born in Vermont, and was graduated as a civil engineer from the University of Michigan in 1869. The same year he entered the employ of the St. Joseph & Denver City R.R. Two years later he went to the Santa Fé system as assistant engineer, and in two years more was made chief engineer. Subsequently he became successively division superintendent, superintendent of bridges, buildings and water service, assistant general superintendent, general superintendent, general manager and second vice-president. During his connection with the Santa Fé he had charge of the construction of more than 4500 miles of line. In 1893 he left the Santa Fé to assume the presidency of the Mexican Central Ry., from which he retired in 1906. Mr. Robinson was a member of the American Society of Civil Engineers and of the American Railway Engineering Association.

T. AIRD MURRAY, sanitary engineer, Oakville, Ont., died recently at Regina, Sask. Mr. Murray went to Canada about 10 years ago, after a long practice of his profession in Great Britain. He was born at Dumfries, Scotland, in 1866. He was consulting engineer to the Saskatchewan Government, a member of the Canadian Society of Civil Engineers, and past vice-president of the Canadian Public Health Association. He was also a member of the American Public Health Association.

AUGUSTUS WILLIAM NEWELL, JR., who was a surveyor on the Massachusetts state survey of the Cape Cod Canal, and on Government work in Idaho, Arizona and elsewhere, died Oct. 26. Mr. Newell had traveled quite extensively, his last work being on railroad location in Western Haiti and irrigation canal surveys in Santo Domingo. He was a brother of Prof. F. H. Newell of the department of civil engineering, University of Illinois.

SHIRLEY ONDERDONK, civil engineer and contractor of New York, died in that city Nov. 16, at the age of 46. After his graduation from Yale University Mr. Onderdonk joined his father in the contracting business, and later became associated with the New York Tunnel Co. He was employed several years ago by the Government in the dredging of Ambrose Channel at the mouth of New York harbor. He had been in charge of the construction of subway tunnel work under the East River.

HARRY LEWIS WELLS, city engineer of Aurora, Ill., and county surveyor of Kane County, died Nov. 7, at the age of 33. He had been engaged in municipal and drainage engineering in that district for the past ten years. He was a partner with his brother, E. Roy Wells, in the Wells Engineering Co., Aurora and Geneva, Ill.

JOHN T. HUETTER, president of the Huetter Construction Co., Spokane, Wash., died in that city Nov. 6 following an accident. Mr. Huetter was 52 years of age.

NEWS OF ENGINEERING INDUSTRIES

FOR MANUFACTURERS WHO SERVE ENGINEERS AND CONTRACTORS

Lumber Association to Study Economic Conditions

Proposed that Board of Direction be Authorized to Increase Assessment to Cover Cost of Study

For the purpose of extending its activities the National Lumber Manufacturers' Association has issued a call on the affiliated regional associations for larger assessments. It is proposed by the executive committee that the board of directors assemble Dec. 16, and that they authorize that the rate be ¾c. per thousand feet for the first three months of 1919, increasing ¼c. every three months until the rate is 1¼c., and to continue at that rate.

The executive committee, at its meeting Oct. 24, concluded that national and international conditions demand wider activities, for the following reasons: The economic conditions of the world are completely upset by reason of war conditions; the policies of nations are now being considered and changed to conform to war needs and to economic evolution; the life and the future of all industry are being affected and molded, and the lumber industry to no less extent than any other.

Industries Must Thrive

It is asserted, furthermore, that the costs of war pyramided and accumulated, requiring drastic methods of taxation, thus creating additional burdens to industry, which in some cases are destructive of incomes; the governments of the world, in order that they themselves may live, desire industry to thrive and consequently require the best informed counsel from industries; post-war conditions require the coöperation of industries within themselves and with the Government to aid in reconstruction.

The essential character of the lumber industry as an instrument of war was a live issue, and the essential character of the industry as a post-war business will be a dominant subject soon; the necessity of having the facts of the industry was never so great as it is now and as it will be in the near future; none of these efforts can be undertaken by the individual in the industry; the regional associations cannot make a national survey of the conditions of the industry and carry on this work as effectively as it can be done by concerted national effort, supported by the allegiance of the whole industry.

Therefore, the committee asserts, the national association cannot protect the individuals in the industry or the regionals without sufficient funds to sustain its services.

Reconstruction Problems Will Receive Close Study at Atlantic City Conference

Questions Sent Out Cover Post-War Labor, Material Supply and Marketing Problems and Government Control

Reconstruction problems, covering labor, materials, marketing, and Government control, will receive attention at the war emergency and reconstruction conference of War Service Committees at Atlantic City next month. It is announced that problems of special interest to each of the committees, numbering 350 or more, will be discussed at separate meetings. A list of questions has been distributed, embodying suggestions for the deliberations of each individual committee on Dec. 3, when they meet as separate units. Further discussion of the questions will follow at 35 group meetings scheduled for Dec. 4, 5 and 6.

It is expected that these deliberations will result in a concrete program, formulated by the business men of the United States, for the solution of the problems of the reconstruction period. The announcement that accompanies the list of questions states that they are suggestive and not exhaustive, and that the general committee will be disappointed if the members of the individual committees do not suggest other subjects which can be discussed with profit.

It is stated that the committees have been appointed for the period of the war. This period is interpreted as extending until the peace treaty has been signed.

Subjects of Discussion

The following are some of the questions proposed for consideration:

What legal methods or means could be introduced in the crafts better to stabilize prices, during the reconstruction period, affected by the following: (a) Inventories on hand; (b) orders placed at war prices but not delivered; (c) labor costs and conditions; (d) increased taxes; (e) increased rates of interest; (f) an estimated increased demand for nonwar materials restricted during the war period; (g) will an increased production of your commodity increase the price of material or labor, or will a controlled redistribution of material and labor from war industries prevent such an increase? (h) discuss the practice of the sale of commodities at a price less than the cost of production; its injury and disturbance on the industries and the ultimate consumer; what methods would you suggest to remedy this evil? (i) if the Government sees fit to dispose of used materials and products in the open market, what effect will it have on your production and the sale of new goods? At home? Abroad? (j) if it is not advisable for the Government to sell these goods on hand, either home or abroad, what shall it do with them? (k) in this connection, what point of contact should business interests have with the Governmental departments in the sale or disposition of these various commodities?

What is your financing problem during the reconstruction period? Do you recommend Governmental aid? Is financial legislation needed? Should the Capital Issues Committee be continued during this period?

What method would you suggest for the cancellation of Government war orders with your craft that would create the least amount of hardship for the industries and permit a readjustment to normal commercial conditions?

Have you any suggestions to make as to the continuation of the War Industries Board or any of its divisions, or any other Governmental departments during the period of reconstruction—such board or departments to have the authority to control materials and regulate prices. If so, for what period?

What intelligent control of materials during the reconstruction period could the War Service Committee suggest which would prevent an over or under supply and avoid a demoralization of the market? Should this be controlled by the crafts or by a Governmental agency?

The value of a uniform method of cost accounting for the individual

(Concluded on page 964)

Road Machinery Manufacturers Have War Service Committee

A war service committee of the manufacturers of road machinery has just been certified to the Government by the Chamber of Commerce of the United States. Nearly 400 war service committees, representing as many industries, already have been formed and have been accepted by the War Industries Board and by other Government departments. The road manufacturers' committee consists of the following: W. R. Wilson, American Road Machinery Co., Kennett Square, Penn., chairman; S. T. Henry, Western Wheeled Scraper Co., Aurora, Ill., secretary; S.

F. Beatty, Austin Manufacturing Co., Chicago, Ill.; Roy E. Adams, J. D. Adams & Co., Indianapolis, Ind.; C. O. Wold, The Russell Grader Mfg. Co., Minneapolis, Minn.

Reconstruction Conference

(Concluded from page 963)

manufacturer and the craft as a whole. What suggestions of the conservation division made to your craft might, with financial profit to your craft, be continued during the readjustment period? Is it possible to maintain a conservation schedule after the war, without legislative authority?

What methods and practices, other than those your craft has already introduced, would simplify production, save materials, eliminate wasteful practices, reduce the number of styles, without destroying individual creativeness?

What effect will foreign competition have on your business? Will it increase or decrease your production?

What disposition should be made by the Government of her merchant marine?

Would you recommend the appointment of a committee of United States manufacturers to confer with similar committees from our allies, to learn of their plans for protecting industry during the reconstruction period? Also to obtain information regarding commodities and supplies needed by them and ourselves during this period?

When the demobilization of military forces takes place, how can these men best be returned to their former industrial pursuits, and how will it affect your labor situation?

What suggestions have you to make to encourage and stimulate public work, such as the building of roads, pavements, water and sewer extension, the construction of public buildings, school houses, etc.? What effect will it have on the labor market? In this connection consider the building program in the United States and especially the utilization or destruction of new plants built for war purposes. Location of convalescent and reconstruction hospitals near industrial centers, so that these men can be trained in the factories nearest to the hospitals without creating new vocational schools.

General Goethals in Charge of War Contract Cancellation

Major General Goethals has been placed in charge of adjusting cancellation of War Department contracts. These adjustments and cancellations will be made in accordance with the views of the War Industries Board, and only orders given since Oct. 1 or those regarding which the contractor states in writing that no disturbance of labor will be caused, may be canceled without reference to General Goethals, it is stated. Contractors are cautioned, however, that no new labor may be engaged on pending war work, and that no new subcontracts shall be let without the approval of General Goethals.

Important Key Industries Shown at Exposition

London Exhibit Aims at Future Development in England and Shows Progress Made During War

The Key Industries Exhibition held in London during October had as its object the preservation, protection and future development of the vital industries of Great Britain, according to Philip B. Kennedy, commercial attaché in London, in a recent issue of *Commerce Reports*. The exhibition was held under the auspices of the Tariff Reform League, and illustrated what the English industries had accomplished during the war in developing the manufacture of essential commodities which had formerly been almost completely controlled by Germany. The exhibition will subsequently be transferred to other industrial centers.

The recent Scientific Products Exhibition, it is stated, dealt with the scientific aspects of the question from an educational point of view, but the stated aim of the industries exhibition was to illustrate the organization side. By organization is meant the Government action for the future protection of the firms which have put capital and energy into the development of these key industries. The term "key industries" is applied to those which in themselves are relatively small, but are of vital importance to the development of greater industries.

German-Controlled Industries

A typical example is presented by the dye industry in its relation to explosives, also by the manufacture of the Bosch magnetos, which prior to the war were manufactured entirely in Stuttgart, Germany, and were used almost exclusively for airplanes, submarines and motor cars. It is stated that magnetos which have been perfected in Great Britain during the war are such that it will be neither necessary nor probable for the demand to revert to Germany. Optical glass is another key industry, making the country independent of Germany for ordinary glass and for glass used in telescopes, searchlights, periscopes, etc. The manufacture of tungsten for use in making high-speed steel, and nickel for armor plate, as well as manganese, lead, graphite, spelter, rubber and antimony, were representatives of other key industries or materials that were exhibited. All of these essential key products, the raw materials of which are largely produced in the British Empire, had been manufactured in Germany and resold to Great Britain.

The British Government has already taken measures to protect many of these essential materials through Parliamentary action. From this it is believed that it will be difficult, if not impossible, for Germany to recover any of its former control. The exhibition was an object lesson in the country's progress toward complete independence.

Bridge and Structural Output 43 Per Cent. Contracted For

The records of the Bridge and Structural Society, as collected by its secretary, show that during October, 1918, 43% of the entire capacity of the bridge and structural shops of the country was contracted for.

Business Notes

The Walter A. Zelnicker Supply Co., St. Louis, Mo., announces the appointment of R. H. Wilson, recently representing the company in Houston, Tex., as assistant to the president, with office in St. Louis. E. O. Griffin succeeded Mr. Wilson at Houston.

C. Nesbit Duffy has accepted the position of vice-president of the Visayan Refining Co., Manila, P. I., one of the largest cocoanut oil companies in the Philippine Islands. He was formerly vice-president of the Manila Electric Railroad and Light Company.

J. C. Rockwell, the present general manager of the Manila Electric Railroad and Light Co., has been placed in full charge of the company's affairs in Manila by the J. G. White Management Corporation, New York, operating the property.

Arthur R. Calvo, for the past five years manager of sales of the Permutit Co., has resigned to become an officer and director of the Hercules Engineering Corporation and its affiliated interests, the Electrolytic Engineering Corporation and the Technical Products Company.

Trade Publications

The Duplex Engine Governor Co., Inc., 36 Flatbush Ave., Brooklyn, N. Y., has issued bulletin 101, describing and illustrating its Duplex and Simplex precision governors, for gas and gasolene engines and motor trucks.

The Independent Pneumatic Tool Co., Chicago, Ill., has issued a folder illustrating and describing pneumatic drills and hammers manufactured by the company. The folder bears a notice to the effect that, at the suggestion of the United States Government, to conserve material and increase the production of pneumatic tools for war purposes, a number of types and sizes have been eliminated, and only the essential types have been retained. The company believes that the sizes and types retained will meet all requirements.